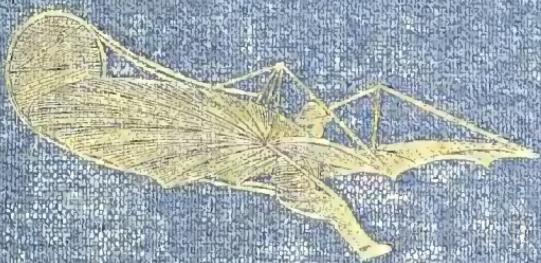


TRAVELS

IN



SPACE

BY

E. SETON VALENTINE
AND F. L. TOMLINSON

WITH AN INTRODUCTION BY

SIR HIRAM MAXIM

Cornell University Library
TL 515.V15

Travels in space; a history of aerial nav



3 1924 004 617 415

engr

Cornell University Library

BOUGHT WITH THE INCOME
FROM THE

SAGE ENDOWMENT FUND
THE GIFT OF

Henry W. Sage

1891

A.1837.95 19/12/04

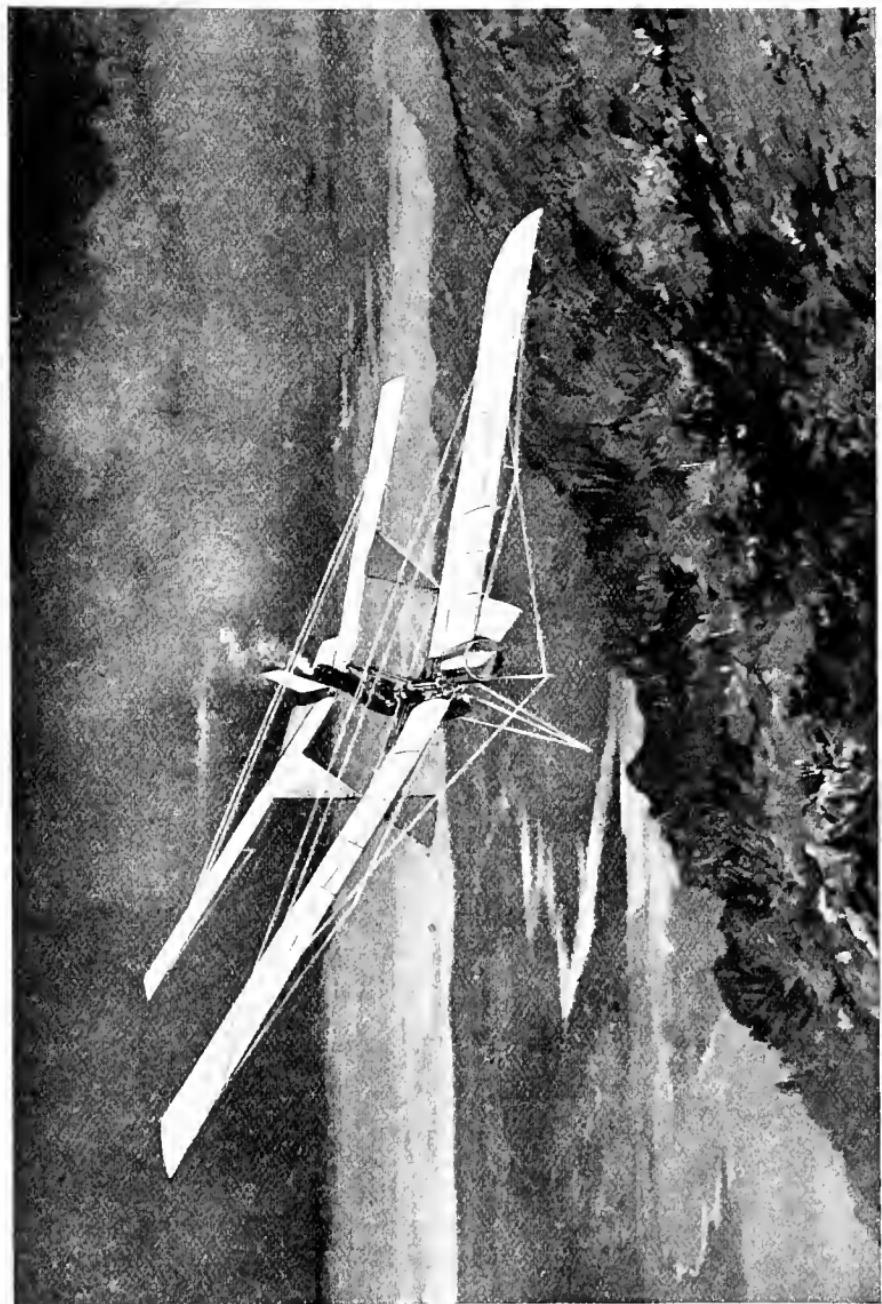


Cornell University Library

The original of this book is in
the Cornell University Library.

There are no known copyright restrictions in
the United States on the use of the text.

TRAVELS IN SPACE



[By Courtesy of the Methuen Company.]

LANGLEY'S AERODROME,

TRAVELS IN SPACE

A History of Aerial Navigation

By

E. SETON VALENTINE

. . and . .

=

F. L. TOMLINSON

—

WITH AN INTRODUCTION BY

SIR HIRAM MAXIM, F.A.S.

PROFUSELY ILLUSTRATED

LONDON

HURST AND BLACKETT, LIMITED

13, Great Marlborough Street, W

1902

All rights reserved

T



PRINTED BY
KELLY'S DIRECTORIES LIMITED,
LONDON AND KINGSTON.

AUTHORS PREFACE.

THERE have been numerous books and treatises on Aerostation, Aeronautics, Aviation and even Aerodromics, but it is the lack of a single one which would present to the ordinary reader, as well as to him technically interested in the subject, a brief but adequate narrative of all the achievements and inventions in this fascinating department of modern science, as well as of the aeronauts and inventors who have thereby distinguished themselves, which has led to the preparation of this volume.

It may perhaps be held that a fitter title for the work would be Aerial Locomotion, in that it is largely concerned with a multitude of haphazard journeys into space whose destination no man could foresee.

On the other hand, the authors may urge that an even greater portion of the book is taken up with accounts of the steady—and often brilliant—efforts of mankind towards a single goal, so that in recounting the hundred and one attempts, in which are involved courage, ingenuity and perseverance, much sacrifice of human life, with not a little humour and pathos added, we have before us in these pages the almost complete drama, as far as it has progressed, of Aerial Navigation.

The illustrations, which form a prominent feature, covering a wide stretch of time, from the devices of Leonardo da Vinci to those of Professor Langley and M. Santos-Dumont, tell one part of this story clearly, and almost of themselves render the letterpress superfluous.

The ingenious Mr. H. G. Wells, whose glimpses into the future have lately afforded the public much entertainment, is confident that we are on the eve of an era of aerial rapid transit. Many eminent hands have been, as we may see, engaged upon the problem; and it is even possible that the means of flight have already been invented and at this moment only await a practical development by the enterprising capitalist.

E. SETON VALENTINE.

F. L. TOMLINSON.

London,
30th May, 1902.

INTRODUCTION.

BY

SIR HIRAM S. MAXIM.

IT is very interesting to find that at last a large number of clever engineers are seriously considering the question of flying machines. About twelve years ago, when I commenced my experiments at Baldwyn's Park, I attempted for a time to keep the whole thing a profound secret, being then unaware that a great number of people relegated those who tried to make flying machines to the same category as those who were looking for perpetual motion and the philosopher's stone. I made, notwithstanding, many very careful mathematical calculations, and found that with the material available at that time it was possible to construct a machine that would lift itself into the air by dynamic energy. Still, I dreaded the ridicule that I felt sure would be heaped upon me when it became known that I was seriously trying to make a flying machine. But owing to my experiments being on a large scale, I found that it was quite impossible to keep the matter a secret, and so it very soon became known that I was seriously working on those very flying machines to which the authors of this book have made allusion.

But since then, happily, public opinion has changed, and an inventor can experiment all he likes on flying machines at the present moment without being regarded either as a crank or a charlatan.

As far as navigating the air with balloons is concerned, it has often been said that Commandant Renard reached the end of the tether, and accomplished all that could be accomplished in this direction. But it appears that Commandant Renard was rather chary about using petroleum motors in the presence of a large amount of highly inflammable gas. At any rate, I am not aware that he has ever attempted to navigate the air with a balloon driven by petroleum engines. Commandant Renard had at his disposal an unlimited amount of skill and cash, but M. Santos-Dumont possesses not only the necessary skill and cash, but also personal pluck to a remarkable degree. M. Santos-Dumont has taken advantage of the new and light petroleum motors which have been developed for the purpose of driving motor-cars, and by attaching one of these to an elongated balloon has succeeded in driving the balloon through the air at a pace considerably greater than ever has been done before. This has enabled him to make short excursions, and to return to the point of departure, even in the face of a slight wind, and this has never been done before. The work of M. Santos-Dumont has been done with balloons as light and strong as it is possible to make them. He has had the advantage of the experience of the French balloon makers, who have probably reduced the balloon to as high a degree of efficiency as regards lightness and strength as it is possible to do. The motor which M. Santos-Dumont employs is the lightest and strongest that modern science is capable of producing at this time. I think we may therefore conclude that as far as balloons are concerned it will not be possible to greatly improve upon what M. Santos-Dumont has already accomplished. He has advanced the science of ballooning further than it has ever gone before ; in fact, I think he has come very near the boundary line, beyond which it is impossible for anyone to go.

A balloon in the very nature of things has to be very light and fragile, otherwise it would not rise in the air. Its mean density is, therefore, less than the air that it displaces, in other words, a mere bubble. If it were possible to make motors which would develop 100-horse power to every pound of weight, it would still be quite impossible to navigate a balloon, no matter how well made, against even a moderate breeze. It is not possible to make a balloon strong enough to be driven through the air at any considerable speed and at the same time light enough to rise in the air; therefore balloons must always be at the mercy of a wind no greater than that which prevails at least 300 days in the year.

Those who seek to navigate the air by machines lighter than the air, have, I think, achieved the limit of accomplishment. They cannot hope for any new developments which will enable them to do much better than they have already done. The possibilities before them are extremely small. On the other hand, those who seek to navigate the air with machines heavier than the air have not even made a start as yet, and the possibilities before them are very great indeed. In all Nature, we do not find a single balloon. All Nature's flying machines are heavier than the air, and depend altogether upon the development of dynamic energy. In Nature's machines the amount of energy developed for a given weight is very great indeed, but no greater than the artificial motors which we are able to produce at the present time. It is quite true that a bird can develop a great deal more energy from a pound of carbon consumed than it is possible to develop with any artificial motor, but on the other hand, Nature has not yet developed a bird that can feed on petroleum, and petroleum carries much more energy in proportion to its weight than any food on which it is possible for a bird to feed. Petroleum motors have already been developed which are sufficiently

light to propel machines which fly after the manner of a bird, and we shall fly whenever we ascertain how this power may be advantageously employed. It is now only a question of time and money.

Although the difficulties which have been encountered by the balloonists in order to reduce the science to its present degree of perfection have been very great, the troubles which beset the men who would make a flying machine are still greater.

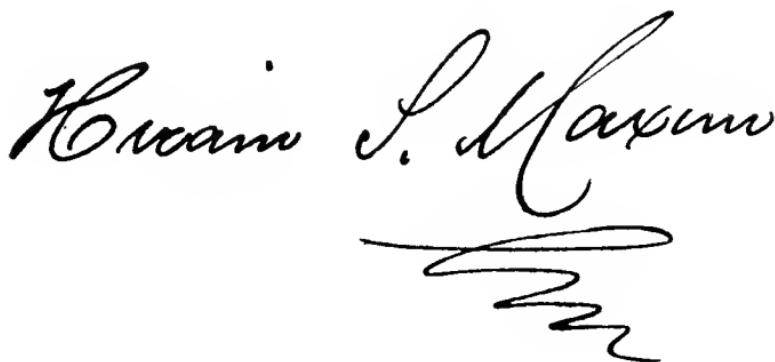
Everything is working in the direction of an early solution of the problem. I do not hesitate to say that in England, France, and the United States there has been fully a million pounds sterling spent in the last six years on experiments connected with the development of gasolene motors for motor-cars, and this development is always in the direction of efficiency and lightness. This is of itself of immense value to those who seek to navigate the air with true flying machines, that is, machines heavier than the air. Then, again, the motor-car industry has done much towards providing suitable materials, such as strong steel tubes and wires, and light and strong aluminium castings, thus furnishing the flying machine experimenter with the exact material he requires without having to pay for the experiments himself.

All the recent experiments that have taken place, disastrous and otherwise, have only served to confirm my opinion that the ultimate solution of the question is undoubtedly in the direction of machines heavier than the air.

Many experimenters in the past have sought to solve the problem by working out systems which they imagined to be new and original. They have spent their time and wasted their money in working over well-beaten tracks that have been travelled by many others before them, and found to be impracticable. Evidently the literature on the subject was not

available, and each of these many thinkers attacked the question exactly as he would have done had he been the first man in the field. I think, however, now that the subject has been popularised by the public press, and more especially by the publication of numerous excellent books of reference, that the would-be navigators of the air will not be forced to commence where others have commenced before them, but rather will be able to direct their attention to that particular point where their predecessors left off.

The present volume appears to have been very carefully considered ; the writers not only describe the various systems that have been employed in the past, but they also give some excellent illustrations. In going over these illustrations, I find certain systems which have been repeated a great number of times ; in fact, among my own correspondence I can turn up hundreds of letters describing machines corresponding with many of those shown in the following pages.



A handwritten signature in black ink, appearing to read "Hiram S. Maxim". Below the signature is a decorative flourish consisting of a horizontal line with a wavy, swirling line extending downwards from its right side.

CONTENTS

	PAGE
CHAPTER I.	I
CHAPTER II.	28
CHAPTER III.	73
CHAPTER IV.	104
CHAPTER V.	133
CHAPTER VI.	178
CHAPTER VII.	208
CHAPTER VIII.	248
CHAPTER IX.	276
CHAPTER X.	305

LIST OF ILLUSTRATIONS.

	<i>Frontispiece</i>
	PAGE
Langley's Aerodrome	<i>Frontispiece</i>
Fac-simile of a Page in the Note Book of Leonardo Da Vinci	5
Besnier, the Flying Man (1672)	11
1. Stephen Montgolfier ; 2. Montgolfier's Balloon ; 3 and 4. Garnerin's Parachute ; 5. Blanchard's Balloon ; 6. Lana's Device ; 7. Charles' and Robert's Balloon ; 8. Oars used by Lunardi : 9. Blanchard's "Wings" ; 10. Modern Balloon	19
Types of Early Balloons	29
Descent of Blanchard and Jefferies near Calais	39
Cloud-land from a Balloon	67
Worm's Navigable Balloon	77
Aerial Flight in the Future	83
Cocking's Fatal Descent	105
Wise's Transatlantic Balloon	111
Henson's Aeroplane (1842)	123
Justafson's Navigable Balloon.	129
Boult's Air-ship	135
Letur and his Apparatus.	137
Le Bris's Apparatus	141
Archibald's Kite Balloon	147
Giffard's Steam Air-ship	149
Project of M. Nadur (1863)	155
David's Sailing Aerostat (vertical section)	163
David's Sailing Aerostat (horizontal section)	165
Landelle's Air-ship	169
Benger's Navigable Balloon	173
De Groof and His Flying Machine	175
Dandrieux and His Machine	177
Mr. Maxim Holding one of His Flying Machine Engines	179
Russell Thayer's American Military Balloon	185
The "Ville d'Orleans" in Norway	195
A Duel in the Clouds	203
Dupuy de Lome's Air-ship	209

	PAGE
Phillips's Aerial Machine	213
Moy's Aerial Steamer	215
The Fatal Ascent of the "Zenith"	217
Tissandier's Electric Air-ship ; Krebs and Renard's Air-ship	221
Night Ascent of Eugene Godard	229
Krebs and Renard's Dirigible Balloon	233
Gabriel Yon's Steam Air-ship	239
Maxim's Flying Machine	241
Santos-Dumont's Dirigible Balloon : A Triumphal Escort	243
Lilienthal and His Flying Machine	253
Lilienthal in Flight	257
Andrée's Expedition—Covering the Balloon	263
Andrée's Balloon—Off at Last	265
The Kite Balloon—Moment of Ascent	267
German Military Kite Balloon	271
Sir Hiram Maxim Giving His Friends a Trip on His Flying Machine.	277
View of the Maxim Flying Machine	281
The Aluminium Air-ship in Mid-Air	284
The Aluminium Air-ship : After the Catastrophe	289
The Zeppelin Air-ship in Shed before Launching	293
M. Severo's Air-ship—The Start	295
The Zeppelin Air-ship Sailing Above Lake Constance	297
M. Severo's Air-ship—The Accident—Avenue de Maine	299
Wölfert's Steam Air-ship.	301
The Santos-Dumont No. 1.	306
The Santos-Dumont No. 2	307
An Accident to Santos-Dumont and His Air-ship	309
Santos-Dumont Giving the Signal	311
After an Accident—The Rescue	313
Rounding the Eiffel Tower	315
In Full Flight : The Return	317
Dr. Barton's New Air-ship	319

TRAVELS IN SPACE.

CHAPTER I.

THE ingenuity and perseverance of man having first rendered the waters subservient to his needs, it was natural that the speculations of philosophers, poets and inventors should be directed to the more daring project of navigating the air.

But notwithstanding the expenditure of much study and not a little physical courage, all such attempts met with scant success; and even when, in 1766, Cavendish had discovered the levity of hydrogen, it was generally conceded that while mankind had triumphed over the difficulties of locomotion on land and sea, it was beyond its power to invade the kingdom of the birds, as it had that of the fishes. This opinion totally perished amongst philosophers soon after Tiberius Cavallo had sent up his small hydrogen balloons; the atmosphere then succumbed to science, and, so persistently has the subject of aviation, as well as aerostation, since been studied, that here and now, at the outset of the twentieth century, it is certain that the upper

realms of space will soon be as traversable, at the will of the tourist, as are the lower.

Without straining for illustrations of our subject in the ancient classics or in the somewhat fantastic writings of the monks, astrologers and sorcerers of the Dark Ages, we may yet cite what has been held to be the earliest recorded instance of actual aerial flight by human beings. Says *le Ministre*, a quaint old historian of the town of Lyons :

“ Towards the end of Charlemagne’s reign, certain persons who lived near Mount Pilate in Switzerland, knowing by what means pretended sorcerers travelled through the air, resolved to try the experiment, and compelled some poor people to ascend in an aerostat. This descended in the town of Lyons, where they were immediately hurried to prison and the mob desired their death as sorcerers. The judges condemned them to be burned; but Bishop Agobard, after questioning them, although he could not believe their story of an aerial journey, gave credence to their innocence and allowed them to escape.”

There seems, however, great scope for doubt whether the scientific principle of the aerial vehicle which is said to have transported these poor peasants and nearly caused their ruin, was that of the modern balloon. Occasional allusions to similar devices and similar incidents greet us in annals of the Middle Ages, showing that somewhere hidden in some secluded monastery, or in some philosopher’s hut at the foot of the Alps, there was a continual groping

after and not infrequently a rude and practical attempt at aeronautical science.

It is not, however, until we reach the times of Roger Bacon (A.D. 1214-1294), styled the "Admirable Doctor," that we begin to approximate the true principles of aerostation.

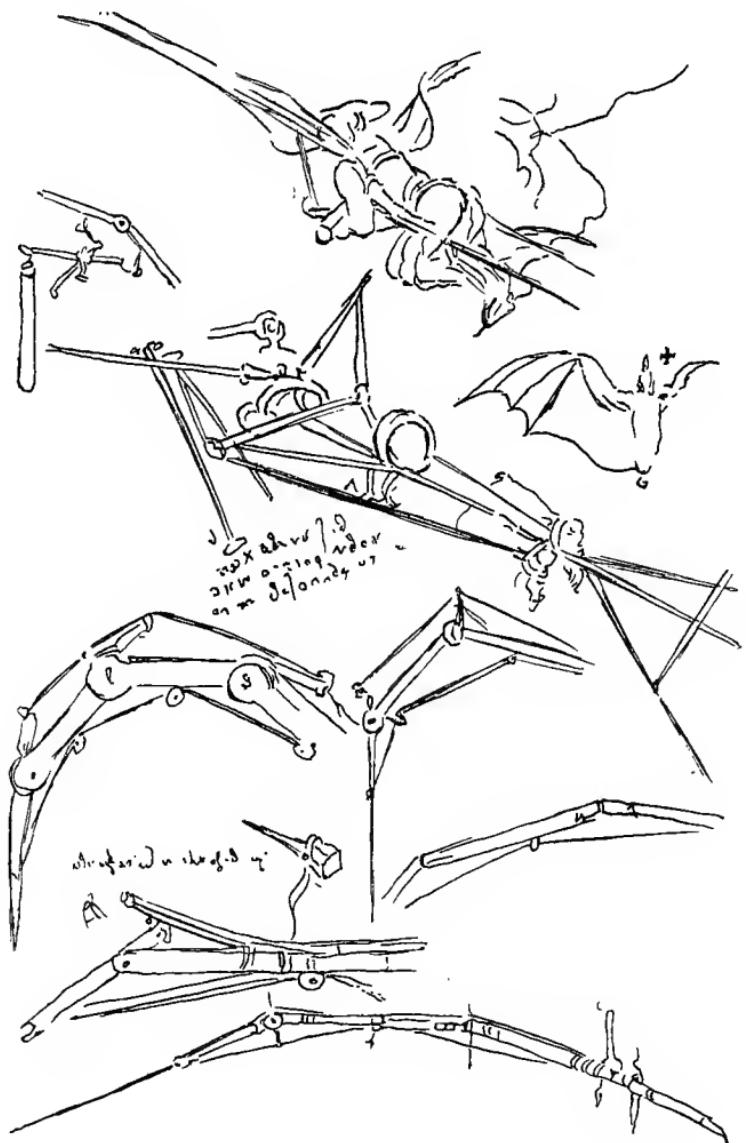
In one of his works Roger Bacon descants in glowing language on a plan for navigating the air. He assumed that the atmosphere is a material of some consistency, capable of bearing vessels upon its *surface*, as ships are borne upon the surface of the water. He then proceeds to describe the construction of his aerial machine "which," he says, "must be a *large hollow globe* of copper or other suitable metal, wrought extremely thin, in order to have it as light as possible. It must then," he says, "be filled with 'ethereal air of liquid fire' and then launched from some elevated point into the atmosphere, where it will float like a vessel on water." It cannot be ascertained from the writings of the philosopher that he ever put into actual practice any of his ingenious projects of flying: but in concluding his treatise upon this branch of his subject, he observes: "There is certainly a flying instrument; not that I ever knew a man that had it, but am particularly acquainted with the ingenious person who contrived it."

By this cautious admission, we see that Friar Bacon was by no means anxious to expose himself to a charge of necromancy on the part of his ignorant contemporaries. Indeed, even in the Middle Ages,

the lives of Montgolfier, of Blanchard, of Green, of Santos-Dumont would not have been worth a day's purchase in any part of Europe if they had been caught on their descent from one of their aerial journeys. The lapse of centuries was to be required before the minds of even intelligent men became familiarized with a spectacle now so common from China to Peru.

But with all due deference to the brilliant prescience of Roger Bacon, it is still evident from his own writings, although some of his admirers have sought to prove the contrary, that he did not fully understand the principles of atmospheric pressure, or he would not have thought it necessary to get his "hollow globe" on the surface of the atmosphere. As to his having some knowledge of the consistency of the air as an elastic fluid, that will not be denied, for at that period the attention of the learned began to be directed to the science of pneumatics. But they had no knowledge whatever of the various and distinct gases.

Soon after Bacon's time, projects were instituted to train up children from their infancy in the exercise of flying with artificial wings, which seems to have been the favourite plan of the flying philosophers and artists of that day. If we may credit the accounts of some of their experiments, it would appear that considerable progress was made in that way. The individual who used the wings could skim over the surface of the earth with a great deal of ease and



FAC-SIMILE OF A PAGE IN THE NOTE-BOOK OF LEONARDO DA VINCI.

celerity. This was accomplished by the combined faculties of running and flying. It is related that by an alternately continued motion of the wings against the air and the feet against the ground, they were enabled to move along with a striding motion, and with incredible speed.

Later, we shall see that this was a gymnastic course in elementary aviation recommended in our own times by such flying men as Lilienthal and Pilcher.

In a London news-letter under the date of September, 1607, occurs this passage :

“The greatest newes in this countrie is of an ingenious fellow, that in Barkeshire sailed or went over a high steeple in a boat, all of his own making ; and without any other help than himself in her, conveyed her above twenty miles by land over hills and dales and so to London.”

This quotation has been held to prove that the science of aerial navigation had been discovered and was practised in England more than a century before the brothers Montgolfier, inventors of the aerostat or balloon, were born. It appears, however, that in 1606 the celebrated Peirescius (Nicolas de Peiresca) came with the French Ambassador to England, was graciously received by King James, and having made the acquaintance of some of the leading Englishmen of letters, went over to Holland. While there he travelled to Scheveningen for the purpose of witnessing a sailing chariot lately made there under the direction

of a celebrated mathematician, Simon Stevinus. Peirescius was much struck by the invention and used to describe "the astonishment he felt at being hurried along, driven by a rapid wind, which was not yet perceived by those in the chariot, for they went as fast as the wind itself." He describes this sailing chariot (not a flying machine) as going from Scheveningen to Putten, about 42 English miles, in two hours. The success of this experiment, made known to Englishmen in the letters of Peirescius, was likely to produce imitators in England as early as September, 1607, and the "ingenious fellow in Barkeshire" was doubtless one of these. He conveyed "a boat of all his own making" "above twenty miles *by land*, over hills and dales"—upon one of which hills he might well be over or above "a high steeple" in a dale—and so arriving at the river, might proceed to London by water in his boat, detached from its temporary wheels. It would thus appear that the above oft-quoted passage had probably no reference to aerostation, but to a species of locomotion long practised in China, Tibet, and even in Spain. If such a discovery had been made at the beginning of the seventeenth century it is not likely it would have been lost. We should have found allusions to it, for instance, in Bishop Wilkins' "Discourse concerning the possibility of a Passage to the World in the Moon" (1638), and in his "Mathematical Logic" (1648). But although this daring writer discusses Stevinus's sailing chariot and also divers means by which flight

might be effected mechanically, he makes no mention of a balloon or any similar means of rising in the air. He does not even appear to be acquainted with the theory of his contemporary Francisco Lana, the Jesuit priest, who proposed to exhaust hollow balls of metal and thus to render them specifically lighter than the atmosphere, oblivious of the fact that such balls would be crushed by the enormous air pressure from without. The barometer, by which the pressure of the atmosphere is ascertained, was discovered in 1643. The weight of the air, as shown by the Torricellian tube, being about fifteen pounds to every square inch of surface, was no doubt the incentive to Lana's proposition of the copper globes. His work, entitled "*Prodroma dell'Arte Maestra Brescia*," in which he describes his machine, appeared in 1670, while the air-pump was not invented, or at least the invention was not made known until 1672. Had the Jesuit father known the exact pressure and specific gravity of the air, his mathematical knowledge would at once have convinced him of the impracticability of his machinery.

The English divine above mentioned, Wilkins, Bishop of Chester, was abreast of the science of the day, and wrote a work entitled "*Daedalus ; or Mechanical Motions*," in which he embodies the sentiments and principles of old Roger Bacon on this subject, giving, however, quainter illustrations to prove that the atmosphere is navigable.

One quotation from the Bishop's work may be

permitted. He thus enumerates "the several ways by which flying hath been or may be attempted."

- 1st. By spirits or angels.
- 2nd. By the help of fowls.
- 3rd. By wings fastened immediately to the body.
- 4th. By flying chariots.

It must be remembered that the tales of the Roc in the "Arabian Nights" were, a century or two ago, widely believed in England.

It was not until Borelli published his celebrated work on the motive power of animals in 1670, showing by accurate calculations the prodigious force which the pectoral muscles of birds must exert and maintain, that the many popular schemes for imitating the fowls of the air, were, except by a few zealous and indomitable persons, abandoned by the human biped. What is probably the first authentic proposal in history to provide man with wings for aerial flight, was made by the celebrated Leonardo da Vinci, painter, sculptor, architect and engineer. It is said that he not only experimented with aerial screws made of paper and to have designed the great parachute, but to have seriously contemplated constructing a machine for flight. It is of this machine that several sketches have in recent times been discovered in his note-book.

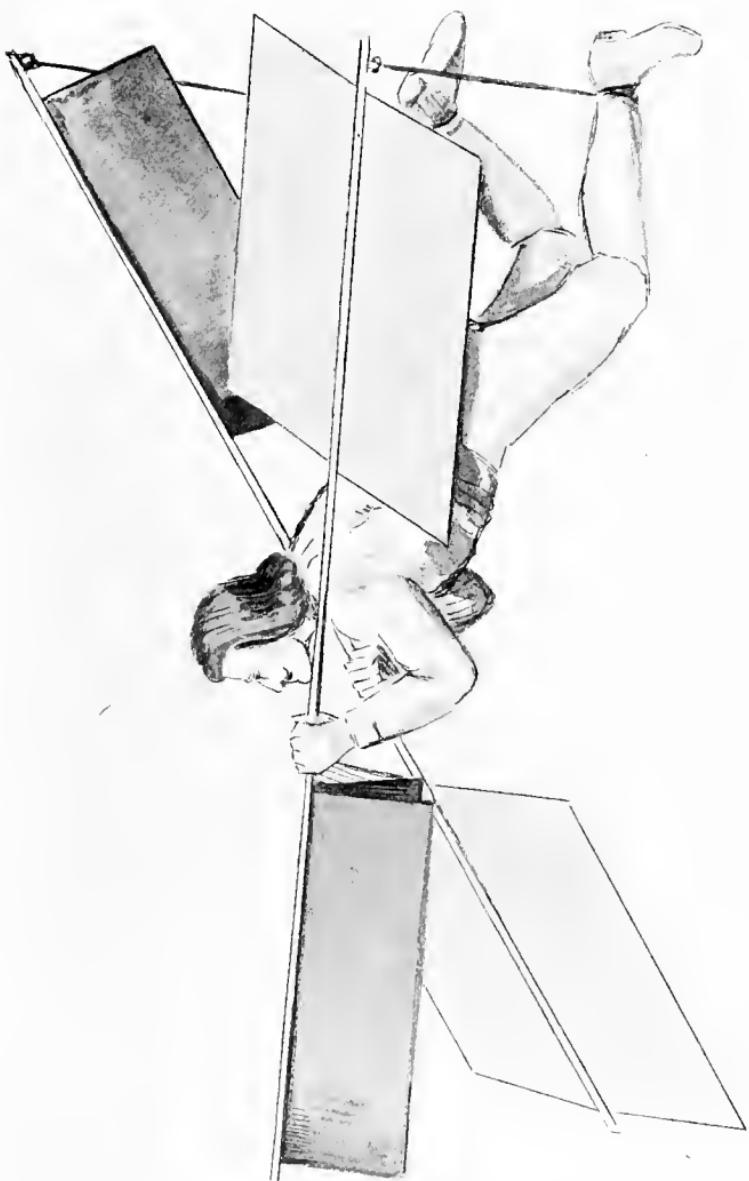
The first sketch shows a wing, actuated by the arms alone, but Da Vinci, soon recognising that all possible muscles of a man must be brought into play to act effectually upon the air, produced other designs, in

which the wings are to be waved downwards by the legs and lifted by the arms. On one sketch, the inventor only shows the legs in place, so as not to obscure the construction of the parts. The date of this is about the year 1500. The construction is, as will be seen, very simple, and were the muscles of men to possess the same energy and rapidity of action as do those of birds, the apparatus might not prove impracticable. How far Da Vinci elaborated his idea is not known, but it is certainly of great interest as a forerunner of actual similar experiments in modern times.

Another sketch has been found amongst his papers for a proposed aerial screw machine 96 feet in diameter, to be built of iron and bamboo framework, covered with starched linen. But the necessary power probably appalled him.

The first known attempt in modern times to fly with artificial wings was made by a French tight-rope performer named Allard, in 1660. He announced that he would fly from the terrace of St. Germain towards the woods of Vesinet in the presence of His Majesty King Louis XIV. It is related that he had previously succeeded in making short flights, but on this occasion his strength failed him, and he fell near the base of the terrace, badly injured.

The apparatus with which, in the year 1678, Besnier, a French locksmith, sought to fly, consisted of a pair of oscillating wings, which however have been only approximately represented by the con-



[From an old Print.]

BESSIER, THE FLYING MAN (1912).

temporary draughtsman. Two bars of wood were hinged over the shoulders, carrying wings of muslin, arranged like folding shutters, so as to open flat on the down stroke and fold up edgewise on the up stroke. They were alternately pulled down by the feet and by the arms, in such a manner that when the right hand pulled down the right wing, the left leg pulled down the left wing, and so on, thus resembling the ordinary movements in walking. It was not pretended by the inventor that he could rise from the ground or fly horizontally through the air. Besnier only tried short distances; having begun by jumping off from a chair, then from a table, then from a window-sill, and next from a second story and at length from the attic, on which occasion he sailed over the roof of an adjoining cottage. Gradually growing more expert, Besnier sold his first pair of wings to a mountebank, who performed with them at fairs and festivals. With his second pair Besnier expected to fly across moderately wide rivers by starting from a height, but as nothing more is heard of his experiments, it is probable his larger feat was never accomplished.

It is not improbable that the Marquis De Bacqueville had benefited by similar practice in private when he announced, in 1742, that he intended, on a certain day, to fly across the river Seine, from his mansion in the Rue des Saints Pères to the Tuileries, 600 feet distance. A huge crowd naturally assembled to witness this flight, and, duly watched, the Marquis launched himself out into space, with large wings

attached to his hands and feet. At first he appeared to succeed, but soon his movements became faltering, and then he fell, perpendicularly, upon the deck of a laundress's barge, anchored in the Seine. He was fortunate in escaping with a broken leg, and the essay was never repeated. He had certainly been well advised in making his experiment over a sheet of water, and could hardly foresee the issue of alighting on an object in the river. Could he have held out but a few feet further he might have escaped with a mere ducking, but his wings, said to be only 24 feet in total area, were utterly insufficient to sustain his weight, except by the most exhaustive muscular efforts.

Just thirty years after this experiment of De Bacqueville, in 1772, the Abbé Desforges, a canon of the church at St. Croix at Etampes, invented a flying chariot having two wings and a small horizontal sail (or aeroplane) attached, measuring perhaps 145 square feet in area. The worthy Abbé expected to rise from a height of a few feet above the ground and to fly horizontally by rapidly beating his wings. But when the machine came to be tried, it was found that although the priest flapped to the limit of his powers, he failed to rise, but tumbled downward instead, narrowly escaping serious injury.

Going back earlier in the century we come across another drama of aerial navigation in which a priest also figured.

It was in the year 1709 that an address was presented to the King of Portugal by an ingenious

friar named Bartholomew de Guzman. In this address the petitioner represented himself as having invented a flying machine, capable of carrying passengers and navigating through the air very swiftly. He also requests the privilege of being the sole possessor of the invention, desiring a prohibition against all and every person from constructing a similar machine under a severe penalty. The King, delighted at the discovery, hereupon issued the following order :

“ Agreeably to the advice of my Council, I order the pain of death against the transgressor. And in order to encourage the suppliant to apply himself with zeal towards improving the machine which is capable of producing the effects mentioned by him, I also grant him the first Professorship of Mathematics in my University of Coimbra, and the first vacancy in my College of Barcelona with the annual pension of 600,000 reis during his life. [Dated] the 17th day of April 1709.”

But the daring inventor was to enjoy none of these benefits. Whatever the merit of his invention, his aims were regarded at Rome as heretical. He was requested to desist ; he replied that his invention, by enabling men to soar in heavens, was not incompatible with divinity. The result was a complaint lodged against him : he was seized by the officers of the Inquisition and flung into gaol. What happened to Guzman thereafter will never be known ; it is believed he perished, perhaps not the only victim of those times,

in the cause of aerial science. There have been many victims since, but these have been due to accidents, and to ignorance, not to religious prejudice.

Yet so recently as 1755, when Father Galien, of Avignon, published a work on "The Art of Navigating in the Air," the force of superstitious public opinion, if not the dread of Rome, obliged him to qualify the title with the additional one of "Physical and Geometric Entertainment." It comprised a wild scheme of ascending mountains and enclosing the light ethereal air found at such altitudes in cotton or canvas structures. As to the machine he had the temerity to project and describe minutely, it was about ten times the size of Noah's Ark, and, says one writer, "could have lifted the whole town of Avignon, where he resided."

Up to the period of the third quarter of the eighteenth century, scientific aerostation, so far as it concerned any knowledge of the nature and levity of the atmosphere, was a sealed book. But there had been for some years an ardent groping towards the light. Hydrogen gas had long been known; but of its character and peculiar qualities little knowledge was diffused. Cavendish found in 1766 that its weight was only about one-seventh part of that of an equal bulk of atmospheric air. So apparent a method, therefore, of obtaining the ascensional power for balloons could hardly long escape the attention of aerial philosophers. Dr. Black, about 1768, made some suggestions as to its employment, and Tiberius Cavallo, an Englishman by

domicile, also experimented with the newly-discovered gas.

The time was now ripe for the man-lifting balloon. In 1783, there resided in the flourishing little town of Annonay, in Auvergne, two brothers named Etienne (Stephen) and Joseph Montgolfier. In a discourse before the Academy of Lyons, the elder Montgolfier himself stated that it was to a French translation of Priestly's "Experiments Relating to the Different Kinds of Air," which came his way, that he owed the inspiration, which resulted in the invention of the balloon. "It was to me," he said, "like light in darkness." From that moment he conceived the possibility of navigating the air.

They were manufacturers of paper, as were all their family for many generations. To one of the early Montgolfiers (which signifies "Master of the Mountain") is ascribed the honour of introducing the paper manufacture into France from the Holy Land, and the father of Etienne and Joseph was the first to make "vellum paper" in the Kingdom across the Channel.

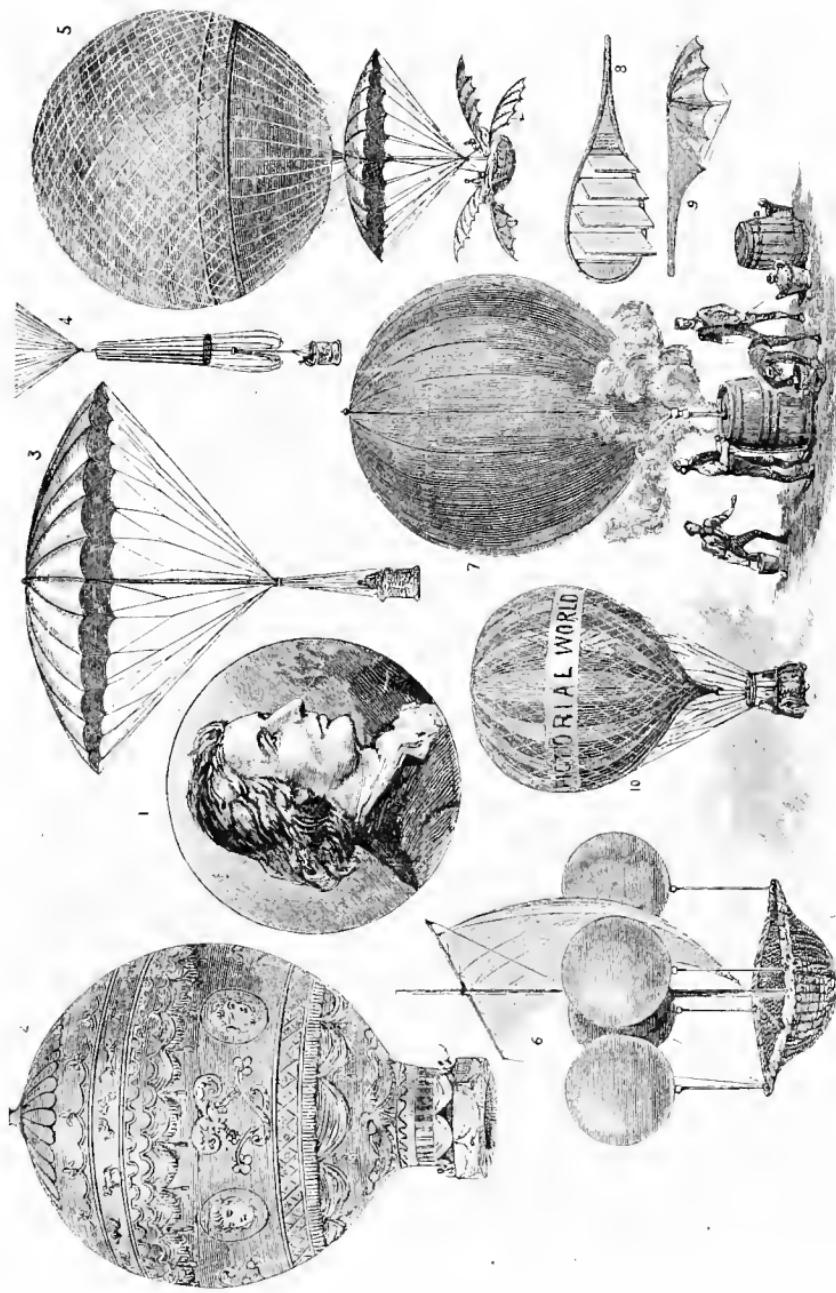
For some time prior to June, 1783, the two brothers had been experimenting, and a rumour spread through all those parts, and even reached Paris, that an invention had been made whereby it would be possible, by the aid of "gases" (a word itself hardly as yet known), to dispatch "a great weight into the heavens which would rise and sail about amidst the clouds and sink to earth at human bidding."

At length, on the 5th of June the brothers Montgolfier resolved to delay no longer the public exhibition of the invention with which they were credited. They therefore sent out invitations to the members of the States of Vivarais, then in session at Annonay, a village in the Lyons district, inviting them formally to witness their new aerostatic experiment.

On the appointed day, a memorable one in the annals of aerial flight, the leading citizens of that part of France foregathered in the wide market place. In the midst of this space stood the two brothers Montgolfier and their assistants. But what riveted the attention of the spectators, and evoked their astonishment, was what seemed to them a gigantic ball, 110 feet in circumference, attached at its base to a wooden frame of 16 feet surface. This enormous bag, with frame, weighed 300 pounds, and was capable of containing 22,000 feet of heated air.

Conceive the increased astonishment of the towns-folk when one of the Montgolfiers came forward and announced that as soon as the interior of this mighty object should contain sufficient "gas" (otherwise hot air produced by burning straw) they would give a signal and it would rise of itself to the clouds. We hardly need to be told that, by the majority of those present, notwithstanding the widespread confidence in the Montgolfier family as paper-makers, the statement was received with smiling incredulity.

"But," says a contemporary account, penned by an eye-witness, "the huge ball swells: it grows



1. STEPHEN MONTGOLFIER.
 2. MONTGOLFIER'S BALLOON.
 3 AND 4. GARNERIN'S PARACHUTE.
 5. BLANCHARD'S BALLOON.
 6. LANA'S DEVICE.
 7. CHARLES' AND ROBERT'S BALLOON.
 8. OARS USED BY LUNARDI.
 9. BLANCHARD'S "WINGS."
 10. MODERN BALLOON.

momentarily larger. Strong arms are now required to retain it. At a given signal it is loosed, rises with rapidity, and in ten minutes attains a height of 6,000 feet ; it proceeds 7,668 feet in a horizontal direction, and gently falls to the ground."

The feat caused the greatest enthusiasm, and the two brothers found themselves the heroes of the hour. Intelligence of the ascent was carried to Paris and throughout Europe ; and the brothers were requested, by the King's order, to repeat their experiment at the capital.

A touch of humour is given to the event by the inventor's own confession that the very first aerial ascent on the principle recorded by Priestly, was of —Madame Montgolfier's silk petticoat ! The lady had stretched it upon a light wicker panier near the fire to dry. The increasing hot air suggested to her husband an intentional acceleration, and to Madame's astonishment the garment began to rise to the ceiling, thereby demonstrating the soundness of her husband's scientific principles, and led to the making of the pioneer linen balloon !

In Paris, the intelligence we have described caused a meeting of savants ; a public subscription was started for defraying the expense of another public ascent. It should be mentioned that the manufacture of inflammable gas (hydrogen) was expensive. One thousand pounds of iron filings and 498 lbs. of sulphuric acid were necessary to fill a globular bag of varnished silk. Yet now for the first time M. Charles determined to apply this principle to Montgolfier's invention.

The filling of the new balloon commenced on the 23rd of August, 1783, in the Place des Victoires, amidst a mighty concourse of people. So vast, indeed, was the crowd which had gathered to witness the spectacle, that it was found expedient to remove the balloon on the night of the 26th to the Champs de Mars, a distance of two miles.

The following is from a description by an eye-witness:—"No more wonderful scene could be imagined than the balloon being thus conveyed, preceded by lighted torches, surrounded by a cortége and escorted by a detachment of foot and horse guards; the nocturnal march, the form and capacity of the body, carried with so much precaution; the silence that reigned, the unseasonable hour, all tended to give a singularity and mystery truly imposing to all those who were unacquainted with the cause. The cab-drivers on the road were so astonished that they were impelled to stop their carriages, and to kneel humbly, hat in hand, whilst the procession was passing."

Almost from daybreak on the following day the crowd began to assemble in the Champs de Mars, which was lined with troops throughout the day. At 5 p.m. the discharge of a cannon gave the signal for the ascent. The mysterious globe rose, to the astonishment of the beholders, to a height of 3,123 feet in two minutes, when it vanished into the clouds. The heavy rain which descended as it rose did not impede and tended to increase sur-

prise. The idea that a body leaving the earth was travelling into space was so sublime ; and appeared to differ so greatly from ordinary laws, that all the spectators were overwhelmed with enthusiasm. The satisfaction was so great that ladies in the latest fashions allowed themselves to be drenched with rain, to avoid losing sight of the globe for an instant.

After remaining in the atmosphere for three-quarters of an hour, the balloon, as a result of a rent in the silk, fell in a field near Gonesse, a village 15 miles distant. The consternation of the ignorant inhabitants of this village has been described :

“ On first sight it is supposed by many to have come from another world ; many fly ; others, more sensible, think it a monstrous bird. After it has alighted there is yet motion in it from the gas it still contains. A small crowd gains courage from numbers, and for an hour approached by gradual steps, hoping meanwhile the monster will take flight. At length one, bolder than the rest, takes his gun, stalks carefully within range, fires, witnesses the monster shrink, gives a shout of triumph, and the crowd rushes in with flails and pitchforks. One tears what he thinks to be the skin, and so causes a poisonous stench ; again all retire ; shame, no doubt, now urges them on, and they tie the cause of alarm to a horse’s tail, who gallops across the country tearing it to shreds.”

A fate precisely similar has since occurred to

other balloons. Some years ago, in Persia, a fire-balloon was let off by some certain French visitors to the Shah's palace. When it alighted, no fewer than three shots were fired at it by the peasantry before they would venture nearer than 50 yards.

It was in order to avert this alarm throughout the country that the paternal Government of France had on the day of the ascent thought fit to issue a proclamation.

"A discovery has been made," so ran this document, "which the Government deems it right to make known, so that alarm may not be occasioned to the people. On calculating the different weights of inflammable and common air it has been found that a balloon filled with inflammable air will rise towards heaven till it is in equilibrium with the surrounding air; which may not happen till it has attained a great height. . . . Any one who should see in the sky such a globe, resembling the moon in an eclipse, should be aware that far from being an alarming phenomenon, it is only a machine, made of taffetas, or light canvas covered with paper, that cannot possibly cause any harm, and which will some day prove serviceable to the wants of society."

It appears certain that however it was viewed by others, the brothers Montgolfier did not attach any extravagant visionary ideas of importance to this invention. With laudable modesty and the simplicity characteristic of men of science, the limits they assigned to its usefulness was the relief of a besieged

town by sending in provisions, the raising of wrecked vessels, and the reconnoitring of the position of an army or of vessels at a great distance. The incentive now being given, during the next few weeks balloons made of paper and gold-beater's skin were sent up by amateurs all over the kingdom. September 19th was marked by another important event. King Louis XVI., his Queen, the Court, and a vast concourse of subjects, so soon to cast off their allegiance, assembled at Versailles to greet M. Montgolfier and his renewed experiment. "About one o'clock the fire was lighted, in consequence of which the machine began to swell, acquired a convex form, soon stretched itself on every side, and in eleven minutes' time, the cords being cut, it ascended, together with a wicker cage, which was fastened to it by a rope. In this cage they had put a sheep, a cock and a duck, which were the first animals that ever ascended into the atmosphere with an aerostatic machine." When the machine went up, its power of ascension, or levity, was 696 lbs., allowing for the cage and animals. The machine raised itself to the height of about 1,440 feet; and being carried by the wind, it fell gradually in the wood of Vauresson, at the distance of 10,200 feet from Versailles, after remaining in the atmosphere only eight minutes. A couple of game-keepers saw the machine descend, so gently that it just bent the branches of the trees on which it alighted. The long rope to which the cage was

fastened, striking against the wood was broken, and the cage came to the ground, without, however, injuring in the least the animals within it, so that the sheep was even found feeding. The cock indeed had its right wing somewhat hurt; but this was owing to a kick it had received from the sheep and not to the ascent or descent.

We now come to an interesting passage in the earlier portion of our story. So far, no human being had dared to risk his life in a balloon mid-air. Indeed, most of the attempts at flying, or ascending into the atmosphere, on the most plausible theories, had from time immemorial destroyed the reputations or the lives of the adventurers. The real test of any scheme of aerostation was for a man to trust himself to the heavens; but as yet none, not even the Montgolfiers themselves, would venture.

The King, apprised of the difficulty, offered a solution. He ordered that two men under sentence of death should be sent up. This suggestion stirred the soul of a young man, named Pilâtre de Rozier, who has rendered his name immortal as the first whose courage was equal to an ascent in an aerostat.

“What, Sire,” he is said to have exclaimed, “are vile criminals to have the glory of being the first to ascend into the air? No, no, that must not be!” De Rozier immediately agitated for a repeal of the royal decree: and at the earnest entreaty of the Marquis d’Arlandes, who offered to accompany him, Louis at length yielded to his request. On

the 15th of October, 1783, in a new and larger balloon constructed by Montgolfier, the memorable experiment was performed in a garden in the Faubourg St. Antoine. On this occasion, de Rozier, in the gallery or car of the balloon, after a few trials close to the ground, desired to rise to a great height. The machine was accordingly permitted to rise, ascending however only as far as the ropes which held it would admit, about 84 feet from the ground. At this height, de Rozier kept it afloat during four minutes and 25 seconds by throwing straw and wool into the grate to keep up the fire. Then the balloon descended gently; but such was its tendency to ascend that, relieved of the weight of its passenger, it rebounded up again to a considerable height. The intrepid adventurer, "returning from the sky," assured his friends and the multitude, who had gazed on his feat with mingled admiration and fear, that he had experienced not the slightest inconvenience whatever of giddiness or shock. However insignificant this exploit may appear in the twentieth century, it marks the accomplishment of what had been for ages desired by man and attempted always in vain.

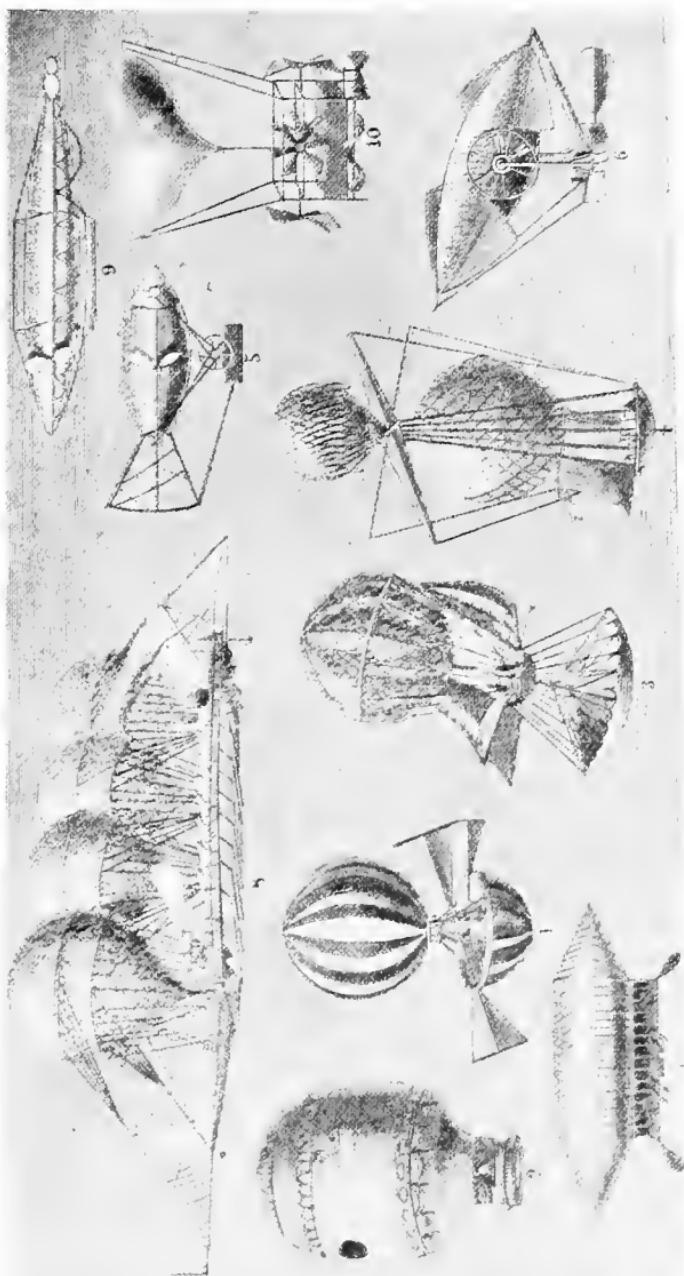
The inhabitants of Annonay still celebrate the memory of their townsmen by an annual fête, an indispensable feature of which is a huge *Montgolfière*, as the hot-air balloon became called. An obelisk also marks the spot opposite which the first balloon *ascended into the firmament*.

CHAPTER II.

A CURIOUS coincidence attended the invention of the balloon, to which we may, however, find a parallel in almost every department of human invention and discovery. For at the very moment the Montgolfiers, Charles and Robert, crowned their endeavours with a practical success, other inventors, in other and different parts of the globe, were on the eve of achieving similar results.

Experiments had been made in Philadelphia, with gas and heated air, simultaneously with those in France. Before anyone had dreamt of ascending in England, on the arrival of the news of de Rozier's ascent, two scientists, Rittenhouse and Hopkins, members of the Philosophical Academy of Philadelphia, constructed a machine, having forty-seven small hydrogen balloons attached to a car, or cage. After some preliminary trials of animals, and with a man in a captive balloon, a carpenter named James Wilcox made a free ascent on the 28th November, 1783. When approaching the Schuylkill River, he grew fearful of falling into it, and punctured the balloon in so many places as to cause too great an escape

TYPES OF EARLY BALLOONS.



of gas, and in the sudden descent dislocated his wrist. This was the first aerial voyage in the Western Hemisphere.

As yet, notwithstanding the invention of the balloon, aerial navigation remained unattempted. So far, ascents had been made in captive balloons only ; it now remained for M. de Rozier and his friend, the Marquis d'Arlandes, actually to undertake an aerial journey, in a horizontal sense.

On the 21st November, 1783, therefore, Stephen Montgolfier made his preparations in the garden of La Muette, a royal palace in the Bois de Boulogne. The machine was filled with hot air, not hydrogen, in a few minutes' time, and the two adventurers placed themselves in the car or gallery, on opposite sides to each other. An unfortunate accident occurred, in which the balloon ignited and narrowly escaped destruction ; but at length, at two o'clock, the machine, weighing about 1,700 lbs. rose amidst the plaudits of the crowd. It passed safely over some high trees and "ascended," we are told, "calmly and majestically into the atmosphere." At a height of 280 feet, the aeronauts took off their hats and saluted the surprised multitude. The wind drove them horizontally over the Seine and over Paris. In passing between the Hotel des Invalides and St. Sulpice, as they were rather low, the fire was increased in order to clear the houses. At last, seeing that the object of their experiment was achieved, no more fuel was supplied, and the machine descended very gently in a field

beyond the new boulevard, after about twenty minutes' aerial travelling. The moment the ground was touched, the Marquis d'Arlandes stepped out: his companion, delaying a moment, was nearly smothered in the collapsing canvas, but sustained no injury.

It is interesting to note that one of the spectators of this memorable, though brief, journey over Paris, was Dr. Benjamin Franklin, who afterwards signed an affidavit concerning it, with other members of the Academy of Science.

The success of the experiment with the inflammable-air balloon made in the Champs de Mars and other subsequent attempts, naturally suggested the idea of making a similar voyage to that just recorded by means of this agent. A balloon was therefore constructed on the plan of M. Charles by two ingenious brothers of the name of Robert. This project was first announced to the public in the *Journal de Paris* of the 19th November, 1783; and a subscription was opened in order to defray the expense, which was calculated to amount to about ten thousand livres. As soon as the balloon was finished it was publicly exhibited at the Tuileries, suspended by a rope from two high trees. It was found to be made of silk gores, covered with varnish, spherical in shape, and measuring twenty-seven and a half feet in diameter. The upper part was enclosed within a net, a rope went round the middle or "equator." To the equator was suspended by means of ropes, a sort of car, or rather boat, which

swung a few feet below the balloon. In order to prevent the bursting of the silk, through expansion of the gas, a valve was made in it, which, worked by means of a string, permitted the excess of gas to escape. There was also attached a long silken pipe, through which the balloon was filled. We may complete our description by mentioning that the car, of basket-work, was eight feet in length and weighed 130 pounds.

It will thus be observed that this machine was distinguished by all the aerostatic appointments with which succeeding generations were to become familiar, the valve, the car, the ropes, the varnish rendering the silk impermeable: even the ballast to regulate, and the barometer to measure ascent and descent, were added. The merit of these devices belongs not to the brothers Robert, but to Charles, their colleague, who may be said to be the inventor of the balloon as we know it to-day.

On the first of December, the Tuileries, the Pont Royal, and all the neighbouring precincts were packed with spectators, anxious to witness the first aerial voyage with hydrogen or inflammable air. A numerous guard of soldiers was there to preserve order, and also to protect the operation; for the spirit of fanaticism was not dead, and more than one priest had expressed in the pulpit his horror of this “tampering with God’s laws.” Another had denounced in set terms the “godless invasion of the inviolability of the firmament.” In the crowd were

observed several individuals of a mathematical turn, friends of the aeronants, who were provided with proper instruments for calculating the height, velocity, etc., of the machine.

Charles himself made his first ascent on this occasion, accompanied by one of the brothers. The pair took with them in the car instruments, a supply of provisions, clothing and ballast. When the balloon had reached the altitude of 600 yards, the two aerial navigators indicated their safety by frequently waving two pennants, though they themselves were indistinguishable from the ground. They crossed the Seine and passed over several towns and villages, to the infinite astonishment of the inhabitants. This voyage lasted an hour and three quarters, the balloon descending in a field near Nesle some 27 miles from the capital. Their speed had been at the rate of 15 miles an hour.

The balloon still retaining a considerable quantity of gas, Charles resolved again to make the ascent. His companion accordingly got out of the car; and it was intended to supply his weight with earth or stone ballast; but nothing of this sort being handy and it approaching sunset, Charles signalled to the peasants holding down the car to let go. "And I sprang up," he writes, "like a bird. In 20 minutes I was out of sight of all terrestrial objects." This was by far the highest ascent yet made, probably not short of 10,000 feet. Charles was the first, too, to experience the inconveniences

upon the human frame of a too-high altitude. "In the midst of my transport, I felt a violent pain in my right ear and jaw, which I ascribed to the dilation of the air in the cellular construction of those organs, as much as to the cold of the external air. I was in a waistcoat and bareheaded. I immediately put on a woollen cap; yet the pain did not go off, but as I gradually descended." As he approached the earth too rapidly, he threw out sufficient ballast to check his flight and alighted in a ploughed field in safety. "Such is the certainty of the combinations of an aerostatic machine," he concludes proudly, "that I might have kept in the air at least for 24 hours longer."

Charles was for this exploit rewarded by the King with a pension worth £200 and his name was ordered to be inscribed on the Montgolfier medal. But, strange to relate, he never ascended again, by reason of a vow made to his family.

Thus, in the progress of a few months, we have seen the birth of the new science of practical aeronautics by means of balloons, with repeated experiments on the other side of the Channel. Yet, although all Europe marvelled, nothing was attempted outside of France. The first relation of Montgolfier's ascent had been read in England with the deepest interest, and it is to be feared with considerable jealousy. The popular prints of the day argued, with some reason, but little amiability, that all the experiments which led to Montgolfier's success had

been made in England. Caricatures of the French balloons and balloonists filled the shop windows of St. James's and the Haymarket, not always in the best taste, to say nothing of draughtsmanship. In spite of all that Englishmen had done in arts and sciences, more than five months were allowed to elapse, before the first aerostatic experiment was shown on this side of the Channel, and then by an Italian. In November, 1783, Count Zambecari, who chanced to be in London, constructed a balloon of oil-silk, 10 feet in diameter and weighing 11 pounds. On the 25th of the month, in the presence of many thousand spectators, this balloon, beautifully gilded, was launched from the Artillery Ground. Two hours and a half later, it descended near Petworth in Sussex, having travelled a distance of 48 miles.

Three months later, and the first balloon that crossed the English Channel was launched from Sandwich, Kent. It was an inflammable-air balloon, five feet in diameter, and being carried over the sea by the wind was picked up in Flanders, nine miles from Lille.

Earlier in the year, on the 19th of January, the largest aerostatic machine then constructed had made an ascent near Lyons. No fewer than seven celebrated persons risked the voyage, amongst whom were Joseph Montgolfier and the intrepid Pilatre de Rozier.

The effect produced on the spectators by this spectacle is described as surpassing in intensity all

that had preceded it. “ Vociferations of joy, shrieks of fear, expressions of applause, the sound of martial instruments, and the discharge of mortars, produced an effect more easily imagined than described. Some of the people fell on their knees, and others elevated their suppliant hands to heaven ; some women fainted and many wept.” Allowing something for the exaggeration of Gallic enthusiasm, the event was yet novel enough to exercise a deep influence over the simple bourgeoisie of that day. At the descent, an accident was narrowly averted, owing to a too great velocity, and the balloon was torn in several places.

In Italy, the Chevalier Paul Andreani, of Milan, was the first who had an aerostatic machine made at his own expense for the purpose of making an aerial voyage, in which attempt he actually succeeded, February 25th, 1784. He was assisted in the practical execution of the work by the brothers Augustin and Charles Gerli, who appear to have boasted considerable mechanical genius.

About the same time, a Swiss, M. Argand, residing in England, made an aerostatic experiment with an inflammable-air balloon, in the presence of the King, Queen, and Royal Family, at Windsor.

After February balloons of all kinds became familiar objects in England and throughout Europe. Two plans were proposed for economizing gas and ballast by the use of compound balloons. The first plan was to have a bag of atmospheric air within the balloon, to be acted upon by means of bellows.

The Duc de Chartres was the first who experimented under these conditions ; but the unfavourable state of the weather prevented the invention from being fairly tried and the duke had a narrow escape with his life. During the spring and summer of 1784 paper balloons, raised by means of alcohol, usually small, not more than four or five feet in diameter, were to be seen flying at all hours of the day and night. "All ranks of people," says one author, "seem to have found pleasure in such kind of experiments ; and so much had the subject engaged general attention, that, both in earnest and in jest, the epithet of *balloon* was annexed to articles of dress, of house furniture, of instruments, etc. Thus, one commonly heard of balloon hats, balloon colours, balloon coaches, and such-like empty phrases."

We now come to the first aerial voyage of the celebrated Jean-Pierre Blanchard, who was afterwards to perform a great number of these excursions. His name had already figured in the scientific world as the contriver of various schemes of flying by mechanical means, in imitation of the birds of the air, without, however, meeting with much success. As soon as he heard of Montgolfier's invention, he instantly resolved to use a balloon for the lifting power and to add the wings of his former scheme for directing his course in the air.

Nearly a century and a quarter has elapsed since then, and the history of dirigible balloons is but the manifold attempts of numberless geniuses to combine



DESCENT OF BLANCHARD AND JEFFRIES NEAR CALAIS.

these two principles; and if success seems at last crowning their endeavours in our own day, it is on the principle sedulously, but fruitlessly, pursued by Blanchard. He constructed a hydrogen-gas balloon, 27 feet in diameter, with a car after Charles's pattern, and to which he added two wings and a rudder. He had likewise a kind of huge umbrella, extended horizontally between the balloon and the boat, with which, in case the former should burst, its descent could be checked. This was the beginning of the parachute.

Blanchard's first voyage, which was made on March 2nd, 1784, was marked by certain singular and romantic incidents. To begin with, the balloon, with the rest of the apparatus for filling it, was carried to the Champ de Mars, the site from whence the first inflammable-air balloon had been launched. As usual, an immense crowd assembled. The machine being filled, Blanchard and a Benedictine monk seated themselves in the boat and the ropes were severed. But they had scarcely ascended fifteen feet when the friar was observed to turn deathly pale and cross himself. The car fell heavily to the ground, owing, it was said, to a leak in the balloon. Not at all intimidated, Blanchard coolly repaired the leaky part, and, as the monk decided to abandon the attempt, made ready to ascend alone. But just as he was setting off, a young man, a student at the Military Academy, forced his way through the throng, jumped into the car, and impudently announced his intention of accompanying the aeronaut.

For a long time, until, indeed, the legend was dispelled by the Emperor himself at St. Helena, this youth was believed by the succeeding generation to have been *Napoleon Bonaparte!*

It was in vain that Blanchard and the rest sought to prevent the young man (whose name was in reality Dupont de Chambon) from making the attempt. His unexpected retort was that he was provided with the King's license; and when he was asked to produce the latter, presented his sword, with which, in his excitement, he wounded Blanchard in the wrist. Finally, the Marquis de Conflans, finding all argument useless, boldly hauled the young zealot out of the car and turned him over to the guards. This extraordinary contretemps over, Blanchard, delivered from both monk and soldier, ascended rapidly. But despite his endeavours, the wings and rudder of his machine appeared to be without effect, the balloon moving with the wind. It crossed the river to Passy, hung in mid-air stationary for a quarter of an hour, re-crossed, and finally descended near Sèvres.

The celebrated geometrician Monge, a member of the French Academy, had previously proposed a method of steering in a manner quite distinct from Blanchard's plan. In place of one, as many as twenty-five spherical balloons were to be attached to each other, like beads upon a necklace, so that they could either lie in a straight line or bend in all directions. Two aeronauts might be attached in a car to each, and receive their orders by signals from the

captain for ascending and descending. Monge supposed that in this way the movement of a serpent in the water could be imitated. His remarkable project was not, however, put into execution.

On the 20th May, 1784, Montgolfier made a private experiment at Paris with a balloon seventy-four feet high and seventy two feet in diameter. In this balloon four ladies made an ascent from the Faubourg St. Antoine, safe-guarded, however, with ropes, which held the machine captive. It was not until the following month that at Lyons, in the presence of the King of Sweden, an actual aerial journey was made by a woman, Madame Thible, accompanied by M. Fleurand.

It is well worth noting the enthusiasm of the French people for the repeated experiments which were made throughout the year 1783, and the two succeeding years, and not less, the munificent patronage which Louis XVI. was pleased to extend to the aeronautical heroes of the day. Thus, he ennobled the father of the Montgolfier brothers, we have seen him bestowing a pension upon the intrepid Charles, and a little later he granted an annuity of 2,000 livres to Pilatre de Rozier. The King, with his most eminent guests and courtiers, was always ready to lend his presence and personal applause to the principal experiments.

It was a singular circumstance, to which we have already adverted, that as yet the same zeal was not manifested in court and scientific circles in England.

A side-light on this circumstance is afforded by an abstract from a letter of Vincent Lunardi, subsequently himself, as we shall shortly see, a famous aeronaut, to his guardian and compatriot in Naples. Lunardi was then resident in London.

“These two nations,” he says, “emulate each other in all circumstances; and the progress and advantage of manufactures are not watched on either side with greater anxiety and jealousy, than a discovery in science, or an improvement in fine arts. This has the happiest effect, as it is accompanied with a liberality and candour that do honour to human nature. The first rumours of aerial voyages were so swollen by the breath of fame, and the imaginary advantages to attend them so rapidly and plausibly multiplied, that the genius of English philosophy, which, since the days of Newton, has borne the palm of science, clouded her brows with a kind of sullenness, and perhaps feared, for a moment, the ascendancy of her sister.”

He adds with truth, that “the glory of a discovery is as indivisible as the atoms of Epicurus; and in respect to aerostation, it remains and must remain with France.” Lunardi was himself contemplating at that very moment an ascent in London; and has even been credited by Cavallo with having accomplished the first aerial voyage in Great Britain. This, however, is not quite true. For in August, one James Tytler, who had previously failed in an attempt to launch a fire-balloon from the Comely Gardens,

Edinburgh, succeeded in making an ascent. The following is extracted from a *London Chronicle* of that era :

“ Edinburgh. August 27th, 1784.”

“ Mr. Tytler has made several improvements upon his fine balloon. The reason of its failure formerly was its being made of porous linen, through which the air made its escape. To remedy this defect, Mr. Tytler has got it covered with a varnish, to retain the inflammable air after the balloon is filled.

“ Early this morning this bold adventurer took his first aerial flight. The balloon being filled at Comely Gardens, he seated himself in the basket, and the ropes being cut he ascended very high, and descended quite gradually on the road to Restalrig, about half a mile from the place where he rose, to the great satisfaction of those spectators who were present. Mr. Tytler went up without his furnace this morning : when that is added, he will be able to feed the balloon with inflammable air and continue his aerial excursions as long as he chooses.

“ Mr. Tytler is now in high spirits, and in his turn laughs at those infidels who ridiculed his scheme as visionary and impracticable. Mr. Tytler is the first person in Great Britain who has navigated the air.”

Early in the previous month, Lunardi addressed the following to Sir George Howard, the Governor of Chelsea Hospital :

"Mr. Lunardi has the honour to acquaint Sir George Howard, that he intends to construct an air balloon, in which he will ascend for the purpose of making some interesting experiments. But previous to his engaging in so expensive an undertaking, he wishes to be assured of a place for launching it, to which none but subscribers can be admitted. If Sir George Howard will indulge him with his permission to launch it from Chelsea Gardens, Mr. Lunardi proposes to devote whatever may exceed the expense of the undertaking to be divided among the invalids of the Hospital.

Mr. Lunardi requests the favour of an answer from Sir George Howard."

The request was granted, the King announced his patronage, subscriptions began to pour in from persons of eminence, and the manufacture of the balloon was proceeded with. But before the appointed day for the ascent Lunardi's plans were unexpectedly upset, and he himself plunged into despair. A Frenchman, named Moret, who was believed to have assisted at some of the trials in Paris, advertised an ascent for the 11th of August, some days previous to his own intended experiment. This unhappy competition, if it succeeded, bade fair to take the wind out of Lunardi's sails. What actually happened none could have foreseen. On the appointed date three or four hundred persons assembled in a garden at Chelsea, at a slight distance from the Military Hospital. Outside the

gates and palings a mighty mob of fifty or sixty thousand persons craned their necks to get a view of the operations. Few in that ignorant mob believed the feat of ascending into the air possible, and it was not long before the delay made them confident of imposture on the part of Moret. After three hours of futile efforts to raise the balloon it suddenly collapsed; the murmurs grew into shouts, the fences were scaled or broken, and the mob rushed in and tore the balloon into a thousand pieces. Not only this, but they committed numerous robberies amongst the company and spread consternation generally throughout the neighbourhood. Moret fled for his life and escaped. After this unlucky episode, it is not surprising to learn that the official permission lately granted to Lunardi should be revoked, and he was informed that he must make his experiments elsewhere than in the Hospital grounds. This decision plunged the aeronaut into despair. We must reflect that he dared not attempt the ascent in an entirely exposed and unprotected place, even if he were prepared to forego the money received from subscribers for seats as spectators. Moreover, he appears to have thought, and not without reason, that his honour was concerned.

“I have already told you,” he writes to his guardian, “that everything respecting Air Balloons has been admitted here with reluctance; the pompous accounts of French voyages are credited, after making large allowances for Gallic vanity; and all hypotheses

respecting a certain and useful application of the discovery are considered as romantic visions. The national prejudice of the English against French is suffered to have its full effect on a subject from which the *literati* of England expect to derive but little honour; an unsuccessful attempt has been made by a Frenchman; and my name being that of a foreigner, a very excusable ignorance in the people may place me amongst the adventurers of that nation, who are said to have sometimes distinguished themselves here by ingenious impositions."

Lunardi attributes his continued popularity to feminine influence: he was not deserted by the ladies of London, who looked upon him as a hero. They flocked to the Lyceum in the Adelphi to see his balloon; the Honourable Artillery Company was induced to grant him permission to ascend in their grounds. But he was not through his troubles. The proprietor of the room at the Lyceum laid an embargo on the machine and apparatus, demanding a percentage in future profits; the Artillery Company grew suspicious, and demanded costly securities. Sir Watkin Lewis came to the rescue, and at last, on the 15th September, all was in readiness for the ascent. Lunardi described the appearance of the vast crowd of 150,000 persons as seeming to him, as viewed from the upper part of the Artillery House, as "a pavement of human heads" which had been stationary for many hours, in upturned expectancy. Few of the ticket-holders availed themselves of their rights, fearing the

fury of the mob in case of failure, but the adjacent roofs, windows, and scaffoldings were packed with humanity. The Prince of Wales was present. It was intended that a Mr. Biggin should ascend with the young Neapolitan, but almost at the last moment the additional weight in the car was found impracticable, and the Englishman reluctantly abandoned his design. The crowd were bawling with impatience; any further delay augured evil. "This event," writes Lunardi, "agitated my mind greatly; a smaller gallery was substituted, and the whole undertaking being devolved on me, I was preparing accordingly, when a servant brought me word that an accident had befallen the balloon which would prevent my intended voyage. I hastened down, almost deprived of my senses, and although I was instantly convinced that the injury was trifling, I could not recover from the shock in time to recollect that I should supply myself with those instruments for observation which had been appointed to Mr. Biggin. I threw myself into the gallery, determined to hazard no further accidents that might consign me and the balloon to the fury of the populace, which I saw was on the point of bursting."

Verily, it took heroes to be aeronauts in those days! But at last the gun was fired, the rope severed, and the balloon rose amidst great excitement and applause. "As a multitude lay before me of a hundred and fifty thousand people who had not seen my ascent from the ground, I had recourse to every

stratagem to let them know I was in the gallery, and they literally rent the air with their acclamations and applause. In these stratagems I devoted my flag and worked with my oars, one of which was immediately broken, and fell from me." By degrees the aeronaut passed high into the heavens, until London appeared only a mist-covered bee-hive to him. As he grew cold, he drank in wine the healths of his faithful friends, and at last, feeling an indescribable calm and triumph, descended gently in a meadow near Ware, in Hertfordshire. While he had traversed over London a Cabinet Council was in progress. On being informed that the balloon was in flight, the King remarked to his Ministers, "We may resume our deliberations at pleasure, but we may never see poor Lunardi again." The conference therefore broke up, and His Majesty, attended by Pitt and the other Ministers, viewed the aeronaut through telescopes as long as he remained above their horizon.

It is not necessary to add that Vincent Lunardi, lately the butt of the ignorant populace, was now a hero, or to describe the many tributes which from the King downwards were paid to his courage and skill.* But it is strange that he should have been described in some of the newspapers as the first aerial navigator in these islands. *The Gentleman's Maga-*

* Subsequently, as, at least, we gather from a contemporary, Lunardi exhibited himself, his balloon and the animals he had taken up, at the Pantheon, at a shilling a head, and is said to have invested between £3,000 and £4,000 in the Stocks as a proof of how balloonation could "raise the wind."

zine, for instance,* correctly describes the ascents of both Lunardi and Tytler, and yet speaks of the former as being the first, when, as a matter of fact he was some weeks behind his Edinburgh rival.

The second ascent in England was made by James Sadler, from Oxford, October 12th, 1784. He is therefore the first Englishman to make an aerial flight.

The third aerial voyage made in England was performed at Chelsea by M. Blanchard and Mr. Sheldon, Professor of Anatomy at the Royal Academy.

Lunardi's success paved the way. All those halting and discredited spirits who had been clandestinely trafficking with the new aerial agents, either not daring or not affording the expense of a public flight, now came forth from their hiding places, and balloon ascents followed each other in quick succession in various parts of the country.

In that year, 1784, "balloonation" as it was styled, took a complete hold on the mind of the public of both sexes. The new "airgonauts," as they were called by the wits, were entertained with greater éclat than if they had been profound philosophers; delighted throngs watched the ascent of "Lunardi's nest," and the town dandies talked affectedly of its reaching the moon, and only complained that their gaze was impeded by the lofty coiffures of the ladies.

"When I heard," wrote Horace Walpole, "how

* Vol. LIV.

wonderfully he had soared, I concluded he had arrived within a stone's throw of the moon ; alas he had not ascended above a mile and a half ; so pitiful an ascension degraded him wholly in my conceit. As there are mountains twice as high, what signifies flying if you do not rise above the top of the earth ? Anyone on foot may walk higher than this man-eagle."

The air ships had the high approval of Burke, and they who sailed in them were glad of his approbation. There was one man who derived even titular honour in these kingdoms from successfully voyaging into space. He was Richard Maguire, who was knighted by the sword of the Lord-Lieutenant in 1785. Yet this was not the first ascent from Dublin, inasmuch as the distinction of making that belongs to a gentleman named Crosbie.

The pioneer of the lady aeronauts was a Madame Thible, who ascended from Lyons in 1784, while the first who ascended in this country was Mdlle. Simonet, in the following year. Pretty Mrs. Sage was the leader amongst Englishwomen who have travelled through the skies.

Soon after Mr. Windham, the first M.P. who took his seat in a balloon car, went up with Sadler from Moulsey, encountering great peril. He came to earth indeed without broken bones, but the "bladder-vessel" was lost. Nevertheless balloons continued to ascend, three in a day. "In short," observes Walpole, "we shall have a prodigious navy in the air,

and then what signifies having lost the Empire of the Ocean?"

As an illustration of the ludicrously exaggerated feelings and sentiments due to the advent of ballooning at this time, we may quote a letter written by a young lady to a friend concerning a balloon ascent she had recently made. "The idea," she says, "that I was daring enough to push myself, as I may say, before my time, into the presence of the Deity, inclines me to a species of terror." She, as well as the other amateurs of her day, were oblivious of the fact that human respiration and, consequently, human life, is only possible for a few miles above the earth, and that man's penetration of the firmament has very definite limits.

In 1784, no fewer than 18 persons ascended from Naples, and during the summer 15 persons went up in a large balloon at Rouen.

Passing over these episodes, possessed of no novel feature which would entitle them to record, we may now mention an aerial voyage of a somewhat remarkable character, the first crossing of the English Channel in a balloon. This was accomplished by Blanchard, who had previously been making a number of voyages, one in company with an American physician named Jeffries, from London to Kent. The same person accompanied him on the present occasion, when he embarked early on the morning of January 7th, 1785, from the edge of the cliff at Dover Castle. Their course was directed towards

the French coast. They passed over several vessels and enjoyed a view perhaps more extended and diversified than any that was ever theretofore beheld by mortal eye. It was soon found that not enough ballast had been shipped and, the balloon continuing to descend, they were obliged to throw over everything portable, books, provisions, the "wings" of the car, anchors, cords, even their chief garments and their only bottle, and were seriously considering the necessity for cutting away the car and clinging to the shrouds, when the balloon began to rise and shortly afterwards the French coast was reached. At last they descended in the Forest of Guines, near Calais, and Dr. Jeffries stopped further progress by laying hold of the branches of a tree. Blanchard was summoned later to appear before the King, who granted him a gift of 12,000 livres and a pension of 1,200 livres a year.

Up to now, when a fatal and dramatic accident has to be recorded, some fifty different persons had effected their ascent into the atmosphere and escaped with their lives, indeed, with two or three exceptions, without injury. On the 15th June 1785, the first and boldest of the aeronauts, his spirit of emulation excited by Blanchard's and Jeffries' exploit, resolved to crown his success by a similar passage of the Channel.

It deserves to be borne in mind that there were now two kinds of balloons, that invented and used by Montgolfier, in which heated air was the agent and the

gas balloon and equipments, devised by Charles. Already there had sprung up in the world of aeronautics a rivalry between the two principles, a difference of opinion as to which method was the best and therefore most likely to prevail. The chief advantage of the rarefied-air machine was its being filled with little or no expense, so that when the provision of fuel was exhausted, the aeronaut might descend and replenish his stock. On the other hand, it must be constructed on a larger scale, in order to carry the same weight, and the constant presence of a fire is a continual trouble and danger.

To this, the Montgolfier party replied that a stroke of lightning or a single tiny electric spark happening near the balloon, might set fire to the invisible contents and destroy both machine and adventurers. Pilatre de Rozier decided to combine the two inventions—in a machine to which he gave the name of the Charles-Montgolfière. He laboured incessantly for six months, on his experiments. He took with him in his ascent in June a friend, M. Romaine. His last tie to earth was the hand of the Marquis de Maisonsfort, to whom he had refused a seat in his car, in spite of his earnest entreaties. The ascent was anxiously watched by thousands, who followed the progress of the balloon for half an hour, when a sudden cry burst from all lips. The wind had changed, they were driven back from the Channel to the land, the machine sprang into flames and after a series of swift, wave-like motions, descended with infinite velocity to

the earth. Hundreds ran to the scene: two bodies lay in the battered car; both were dead.

Thus perished the first aeronaut, Pilatre de Rozier.

Instantly a clamour arose in France, amongst the friends of the intrepid young man, averse to any further aerostatic experiments. It was echoed throughout Europe. A wave of pessimism set in. Persons who had lately been exulting over the near prospect of subduing the elements and solving a world-problem, now grew despondent. Further sacrifices of human life were deprecated. The vast majority who had regarded the experiments of the past two years with doubt and misgiving, now proclaimed that Providence had seen fit to end the reign of criminal folly. They forgot that useful discoveries of every kind demand sacrifices: that even the navigation of the sea costs mankind many thousands of victims. Before Cavendish's researches Science had announced the impossibility of man ever rising in the air; and the feat was impossible with the then known forces.

“The balloon,” remarked a French writer of that day, deprecating the threatened reaction,* “has accus-

* In one of his letters to Sir Horace Mann, Walpole says: “The Balloonomania is, I think, a little chilled, not extinguished, by Rozier’s catastrophe. That it should still blaze in my nephew” (George, Earl of Orford) “is not surprising; not that he has mounted himself—he did threaten it: but real madmen are not heroes, though heroes are real madmen. He did encourage another man, who, seeing a storm coming on, would have desisted: but my Lord cried, ‘Oh! you had better ascend before the storm arrives,’ and instantly cut the strings; and away went the airgonaut, and did *not* break his neck.”

tomed us to prodigies, and reason has a right to expect new ones." He might have quoted a saying of de Rozier himself to his friend the Marquis de Maisontort. "We have lived long enough when we have added something to humanity." *

As yet the experiments towards guiding balloons had met with little success. But this did not discourage a score of inventors from resolving the most difficult problem that aeronautics had to solve. In June, 1786, Testu-Bressy made an ascent from the gardens of the Luxembourg, in order to test his steering apparatus. He purposely descended in a field in order to obtain more ballast; the field turned out to be a vineyard, some vines were injured, and the proprietor set upon the aeronaut, confiscated his coat and broke his "oars." Subsequently, Testu-Bressy accomplished some further experiments in the way of guiding his machine, but these led, like the rest, to nothing. Once, to prove his assertion that the blood of large animals, although less fluid than man's, would flow from the nose at a much lower elevation, he ascended on horseback, without tying the animal to the car, or perceiving in it the least fear.

Already, although ballooning was scarce three years old, there had sprung up a literature of its own. First, each of the successful aeronauts felt himself in duty

* A monument was erected to mark the spot where the aeronaut and his companion met their disaster, with the following epitaph for de Rozier:

"Victime avoué de la rigueur du sort
Le chemin de l'honneur te conduit à la mort."

bound to give to the world an account, often to the pettiest details, of his exploits. One of the best of these extant is that by Lunardi, whose narrative is really distinguished by literary skill and attracted a wide attention. Then came the treatises and commentaries of the theorists, who, often not practical aeronauts themselves, yet followed the new science and its developments with enthusiasm. Thus we have the works of Meusnier, Bourgeois, Southern, and the "History of Aerostation" by Cavallo. To these may be added the quaint brochure of Thomas Baldwin of Chester, entitled "Airopaida," describing his experience in the atmosphere. He tells us that on the first ascent he took out his note book and pencil, "but a tear of pure delight flashes in his eyes, of pure, exquisite delight and rapture," and so on for pages of flowery, purple prose.

During the autumn of 1785, Lunardi made other ascents, at Edinburgh, Kelso and Glasgow. On the Continent, Blanchard ascended from Brussels, Berlin, and numerous cities as far as Warsaw, gaining great reputation. On the 7th August, 1786, Balmat and Pascard reached the summit of Mont Blanc; Blanchard was preparing to execute that feat, only waiting until some further results were ascertained concerning the effect upon the human body of high altitudes. The invention of the parachute has been ascribed to Leonardo da Vinci, and perhaps more justly to Blanchard, but the patent was granted to Garnerin many years later, and it is he who certainly

made the most useful developments of this instrument, as will be recorded below.

Although it is highly improbable, notwithstanding the many attempts on the part of aspiring inventors both before and since the Sieur Besnier, that any man has ever actually flown in the air by means of muscular or mechanical power until the era of Degen or Lilienthal, yet the problem of such artificial flight has always engrossed the minds of inventors, and when, in due time, the reaction against ballooning as a means of flight set in, we shall note from time to time many such projects of wing-machines.

As early as 1784, when the first ascensions were exciting the public imagination, the first projectors came forward with plans for different systems of flying machines. Gerard, for example, in that year published his "Essay on the Art of Aerial Flight," in which he gives a design of a machine of his own invention, naïvely omitting, however, the most essential particular, the motive-power. In the same year, also, Charles Macriven, architect of the Prince of Wales, proposed to construct a large apparatus for the use of a flying man.

The French Revolution now supervened. France, the leader in this branch of science, was plunged in civil strife and bloodshed, and further aerostatic experiments abruptly ceased. Yet the possible value of the balloon in warfare did not fail to arrest the attention of certain military experts. A military aerostatic corps was formed in that year of terror, 1793, and

Napoleon Bonaparte, just rising into renown, lent the idea his strong encouragement. He even employed balloons in his Egyptian campaign for impressing upon the Arabs the superiority of European arts over those of Africa.

The Aeronautic School at Meudon was inaugurated with the utmost secrecy, so that the enemy could not avail themselves of the advantage until the first projectors had already used it in such a manner as to inflict an effective blow. Its management was entrusted to Guyton de Morveau, a celebrated chemist, and Colonel Coutelle, and fifty young military students were admitted to the school, some of whom afterwards became well-known aeronauts. A hydrogen gas balloon of 32 feet diameter was constructed for demonstrations amongst these pupils. Whenever the weather was fair, the colonel of this ballooning corps and a pupil seated themselves in the car, and the machine was suffered to rise 500 or 600 feet by means of rope and windlass. A fine view of Paris, then the great military focus of Europe, could thus be obtained. Special balloons were in due course constructed for the different divisions of the army, great importance being attached to these machines, which were given distinctive and high-sounding names. The "Entreprenant" for the army of the North, the "Celeste" for that of the Sambre and Meuse, the "Hercule" for the army of the Rhine and Moselle, and the "Intrepide" for the memorable army of Egypt.

In June, 1794, Coutelle ascended in the war-balloon

“*Entreprenant*” to reconnoitre the hostile army, just before the battle of Fleurus, accompanied by an adjutant and general. They rose to a height of several thousand feet, with their windlass machinery so arranged that they could make it stationary at any given altitude. Twice in the course of that day they mounted, each time remaining up about four hours. During the second of these aerial reconnaissances, they were discovered by the enemy, causing some little surprise and even consternation in their lines. Nevertheless, a brisk cannonade of the aerial man-o’-war was set up, without any other effect than that of causing the “*Entreprenant*” to mount to a sufficiently high altitude to be outside the range of the cannon. When they descended they communicated by signals to General Jourdain valuable information, which directly contributed to a speedy and decisive victory over the Austrian forces.

After this very different was Coutelle’s reception from the one he had met on his arrival within the French lines with his balloon. He had arrived at Beaumont covered with mud, and presented his letter to Duquesney, who held the office of Commissioner of the Convention with the army of the North. The invidious duty of this personage was “to see that the soldiers went into battle, and to force the generals to conquer under menace of the guillotine.” He was at dinner when the newly-appointed military balloonist arrived, and had heard nothing about the school at Meudon. “A balloon!” he cried, in contempt and

incredulity, "a balloon in camp! You appear to me a suspect, and I believe it would be well to have you shot." This choleric, bloodthirsty person, however, listened to reason, and sent Coutelle to General Jourdain. On his return he loaded him with compliments on his skill and devotion. The Austrians themselves were not far behind in their praise.

"It is only Frenchmen," they repeated, "who are capable of imagining and executing such an extraordinary enterprise."

Two of Coutelle's balloons may still be seen by the tourist, one in the Kaiserliches Zeughaus in Vienna, and the other in the riding school at Metz.

Early in the war Garnerin was sent by the Revolutionary Tribunal to the army of the North, and at the close of a fierce battle made prisoner by the Austrians and Prussians. During his incarceration of nearly three years in the fortress of Buda, in Hungary, he spent his leisure in planning a novel escape.

"The love of liberty," he wrote afterwards,* "so natural to a prisoner, gave rise to many projects to release myself from the rigorous detention. To surprise the vigilance of the sentries, force walls ten feet thick, throw myself from the ramparts without being injured, were schemes that afforded recreation." Blanchard's idea of presenting large surfaces to the air to increase its resistance, and the known acceleration of movement in falling bodies, seemed to Garnerin only to require a careful mathematical comparison to be

* In the Programme of his first descent in a parachute, 1797.

employed with certain success ; and he accordingly applied himself to the problem of the parachute.

Three years later he put his ideas into practice. We read in a contemporary account :

“At 5 p.m. on the 1st Brumaire, An. VI. (22nd October, 1797), the citizen Garnerin rose from the park of Monceau. A solemn silence pervaded the multitude ; excitement and uneasiness were depicted in every countenance. When he had reached an altitude of more than 6,000 feet, he cut the cord that attached him to the aerostat, which ascended till it exploded, whilst the parachute with the citizen Garnerin descended rapidly. The oscillations it underwent drew forth a cry from the spectators, and many women fainted. However, the citizen Garnerin descended on the plain of Monceau, got on horseback immediately and returned to the park, in the midst of a crowd who loudly testified their approbation of the talent and courage of the young aeronaut.”

It should here not pass without comment that all the first aeronauts, hardly without exception, were young men. Their average age was twenty-five ; Pilatre de Rozier was twenty-eight when he died.

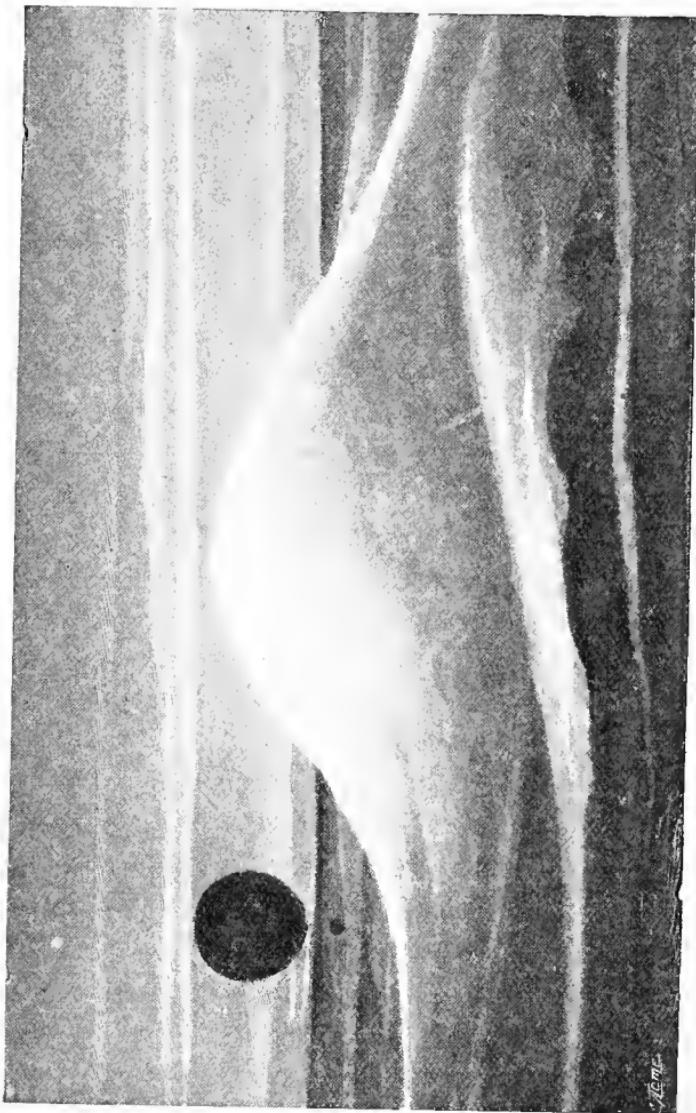
Garnerin came to England in 1802 and made a number of successful voyages. The most famous was that from Chelsea to Colchester, a distance of 60 miles in 45 minutes. Its passage created the utmost excitement, no balloon hitherto had sped so directly over London,

or had ever been gazed upon by so many spectators. On another occasion he passed from Marylebone to Chingford, 17 miles in 15 minutes. Once he descended in a parachute from a height of 10,000 feet. "I took out my knife," he wrote, "and with a hand firm from a conscience void of reproach, and which had never been before against any one but in the field of victory, I cut the cord. My balloon arose, and I felt myself precipitated with a velocity which was checked by the sudden unfolding of my parachute; I saw that all my calculations were just, and my mind remained calm and serene. I endeavoured to modulate my gravitation, and the oscillation that I experienced increased in proportion to my approach to the breezes that blow in the middle regions. Nearly ten minutes had elapsed, and I felt the more time I took in descending, the safer I should reach the ground. At length I perceived thousands of people, some on horseback, were following and encouraging me. After one bound I quitted the parachute without accident. I was instantly seized and carried in triumph; but sickness had been produced by the rocking, which always had this effect on me, so I obtained permission for a few minutes' repose and then got on a horse." Among the horsemen he relates that he saw the Duke of York, Lord Stanhope, and Sir Sidney Smith, the latter of whom came to him on purpose, as he said, "to shake hands with a brave man," a compliment of some value from the lips of one of the bravest soldiers in Europe.

In the following year a singular and fateful ascent was made from Bologna, by Count Zambeccari and two companions. It was made at midnight, for the simple reason that the inflation was delayed till that time, and the assembled populace in its impatience refused to wait until morning. We see that the hydra-headed monster plays a very tyrannical part throughout the whole of the early history of balloons. Nothing daunted, the intrepid trio took with them lanterns and other instruments for nocturnal observations. At an altitude of five miles they nearly perished with cold, and two of the occupants of the car fell into a dangerous slumber. After two hours the balloon fell slowly, and on awaking the trio found themselves touching the waves of the Adriatic. Drenched to the skin, and in the pitch darkness they threw out ballast and rose into a dense cloud, where they experienced deafness ; and their clothes were covered with rime. After three o'clock, for five hours they hovered between sea and sky, in imminent peril of drowning, and at last, on the coast of Istria, they were picked up by a passing vessel, in a sad state of prostration. As for the balloon, a Montgolfière, it disappeared, and afterwards fell in some part of Turkey. Zambeccari continued his aerial experiments, and lost his life in a balloon in 1812.

Following on the capitulation of Cairo and the return of the French army, the balloon which had been sent by Napoleon's orders to Egypt was returned to Paris. Two young men, Gay-Lussac and Biot, obtained permission of the Government to use this balloon for the

purpose of making some investigations into the "constitution of the higher atmosphere and its electrical properties." Both were graduates of the Polytechnic School and qualified chemists. They were equipped with the best instruments then extant and available. To examine the electricity of the different strata of the atmosphere they carried several metallic wires, from 60 to 300 feet in length, and a small "electrophorus" or battery, feebly charged. For galvanic experiments they had procured a few discs of zinc and copper, with some frogs, birds, and insects. They also designed to bring down a portion of the air from the higher regions to be subjected to a chemical analysis, and for this purpose a flask, carefully exhausted and fitted with a stopcock, was prepared. The ascent was made on the morning of the 23rd August, 1804. The story of this voyage of discovery marks an interesting stage in the history of aeronautics. These young men appear to have made up their minds to let nothing escape them; they noted everything, they analysed everything. Some of their experiments were, perhaps, a little fantastic. They liberated a violet bee at an altitude of nearly 10,000 feet, "which flew away swiftly making a humming noise." A green linnet also flew away, but at first, finding itself abandoned in that immense ocean of air, returned and settled on the stays of the balloon. "Then, mustering fresh courage, it took a second flight and dashed downwards to the earth, describing a tortuous yet almost perpendicular track." A pigeon, similarly released, afforded a more curious spectacle.



CLOUD-LAND FROM A BALLOON.

“Placed on the edge of the car, it rested a while, measuring, as it were, the breadth of that unexplored sea which it designed to traverse; now launching into the abyss, it fluttered irregularly and seemed at first to try its wings on the element, till, after a few strokes it gained more confidence, and whirling in large circles or spirals, like the birds of prey, it precipitated itself towards the mass of extended clouds, where it was lost to sight.” This was the pioneer of the race of pigeons at that altitude, and surely no bee or linnet had ever approached so near the sun.

It was found difficult, in those lofty and rather humid regions, to make electrical observation, so the chief attention of the scientific pair was directed to magnetic experiments. Yet they lowered from the car an insulated metallic wire some 250 feet in length, and ascertained by means of their instrument that the upper end indicated resinous or negative electricity; and this experiment, several times repeated, appeared to corroborate fully the previous observations of Saussure and Volta concerning the increase of electricity encountered in ascending the atmosphere. After numerous other experiments they descended; but on reaching the ground there was no human being in sight to stop the balloon, which dragged the car swiftly over the fields. Biot was so affected by this alarming experience that, although not deficient in courage and endurance, he quite lost his senses for a time. The balloon was punctured and the aeronauts were set down fifty miles from Paris. Gay-Lussac, during the following month,

made another ascent with interesting results, these two voyages being memorable as the first ever undertaken purely in the interests of science.*

In December of the same year occurred the Coronation at the hands of Pope Pius VI. of the Emperor Napoleon I. Amongst the acts of public rejoicing appointed by the Government to celebrate this event was the ascension from Notre Dame of a mighty balloon. The event proved memorable: it was the last balloon Napoleon patronised: it is said, indeed, that from this time the Emperor evinced an unconquerable aversion to the science of aerostation, and was even led to look upon the generality of inventors with distrust and antipathy. The story of this strange, and, to the fatalistic mind of the Emperor, supernatural voyage, is soon told.

The commission for the ascent was entrusted to Garnerin, who had previously been created "aerostier des fêtes publiques." "I hope," wrote Champagny, the Minister of the Interior, "that you will be able to economise, as the Government has decided on not spending more than 23,500 francs on your account." On the 16th of December, then, at eleven at night, the wondrous balloon, covered with a huge gilt inscription,

* De Fonvielle, Green, and other aeronauts have had, however, great doubts as to the heights attained by Robertson and Gay-Lussac. Green could not "understand how it was they did it with balloons of such small size." It is true they used hydrogen, but there must have been very little of it left on returning to the earth, if the diameters of their balloons were no more than stated. Mr. Coxwell has also cast doubt on the reports of the performance of these early scientific aeronauts. It was mathematically impossible, he added, for a balloon of that size to rise so high.

rose slowly and with majesty from the square of Notre Dame. It is illumined by fully 3,000 lights, and furnishes a brilliant spectacle to all beholders, amongst whom is Napoleon himself. There is much speculation as to where it would alight; certainly the Emperor already attributed a curious importance to this detail. "On the following morning, at daybreak, some of the inhabitants of Rome see at the horizon a brilliant globe advancing towards their city. It is soon over St. Peter's and the Vatican; descends, rises again, somewhat torn; keeps to the ground, and falls into Lake Bracciano." The fact that the descent had been made, of all places, at Rome, was sufficiently astonishing; the rapidity of its flight was a minor miracle.

Las Casas, in his "Private Life of Napoleon at St. Helena" (Vol. III., p. 313), says: "He mentioned, as a sort of prodigy, the circumstance of the balloon which ascended at his coronation having fallen, in the space of a few hours, in the neighbourhood of Rome." But the evil omen, which so powerfully affected the Emperor's mind, is not there mentioned; it seems almost incredible. The balloon in its course over the ground left part of its crown on an angle of the tomb of Nero! The Italian papers, not being under such rigorous censure as those of France, innocently related the coincidence; some, however, added malicious remarks, injurious to the Emperor. The affair was duly reported to Napoleon at one of his levées; he instantly showed his discomfiture, and ordered that no further comment should be made on the subject.

Garnerin was subsequently discharged ; the Military Aerostatic School at Meudon was abandoned, and although occasional ascents were permitted, Napoleon thereafter lost all his interest in ballooning. It remains only to add that this famous Coronation balloon was suspended in a corridor of the Vatican, where it was on view till 1814, with an inscription and date, omitting, however, any allusion to the tomb of Nero.

CHAPTER III.

SCIENCE rarely lags for want of a terminology, and in the phrase aviation we have, in later times, come to express that school of aeronautics which seeks to imitate the flight of a bird.

Thus the fabled Dædalus and Icarus flying from ancient Crete, Simon the Magician, Oliver of Malmesbury, Sarrasin of Byzantium, Besnier, and the rest, would now be termed aviators.

We have already seen that Leonardo da Vinci attempted the invention of wings for human use, and have also noted the other experiments up to Blanchard's abandonment of his flying machine for the newly invented balloon in 1784.

In that year the first proposal for a flying machine equipped with a motor came from one Gérard, who seems to have provided, in addition to body and wings, for a steering arrangement in front. It is said that escaping gases and gun-cotton were to furnish the propulsion. But such great things were expected of the balloon that there is a gap of a quarter of a century before the aviators had courage to renew their attempts. In 1809 a Viennese watchmaker of the name of Degen

contrived an apparatus for mechanical flight on the principle of wings, worked by his own strength. Degen's machine was formed of two parachutes of taffeta, which might be folded up or extended at pleasure. The inventor being placed in the centre. He made several public experiments, and rose to the height of 54 feet flying in various directions, with the celerity of a bird. A subscription was opened at Vienna to enable him to prosecute his discoveries.

This experiment gave rise to much speculation in aeronautic circles, and an English scientific student and aeronaut, Sir George Cayley, contributed an essay upon the subject, in which he sought to show that the idea of aerial flight independent of the balloon, was most plausible. A motive power only was desired.

“Since the days of Bishop Wilkins,” Cayley remarked, “the scheme of flying by artificial wings has been much ridiculed ; and indeed the idea of attaching wings to the arms of a man is ridiculous enough, as the pectoral muscles of a bird occupy more than two-thirds of its whole muscular strength, whereas in man the muscles that could operate upon wings thus attached would probably not exceed one-tenth of his whole mass. There is no proof that, weight for weight, a man is comparatively weaker than a bird ; it is therefore probable if he can be made to exert his whole strength advantageously upon a light surface similarly proportioned to his weight as that of the wing to the bird, that he would fly like the bird and the ascent of Mr. Degen is a sufficient proof to the truth of this statement.”

Sir George Cayley suggested the use of the steam-engine in providing the power necessary for mechanical flight. He described his own experiments with a flying toy, operated on the screw principle, which has been repeatedly discovered and re-discovered from the time of Archimedes to our own day. But steam was as yet too much in its infancy to permit any practical demonstrations of its efficiency, in obtaining a solution of the problem, and the Boulton and Watt engine proposed by Cayley was altogether too heavy for the purpose.

In the year following Cayley's propositions, Thomas Walker, of Hull, published a pamphlet on "The Art of Flying," in which he described a method for "making a flying car with wings, in which a man may sit and by working a small lever cause himself to ascend and soar through the air with the facility of a bird." In early life, the author tells us, he had dissected a great many birds and had since studied very minutely the mechanism of their wings, tails and all the parts which they employ in flight. He, therefore, proposed a machine not greatly differing from Degen's, with the addition of a sail of an equilateral triangle spread horizontally over the flyer's head, for occasional use.

Walker's proposition was really a most interesting one, but he does not appear to have been endowed with the physical courage and tenacity requisite to put it into practice, such as was eighty odd years later shown by Otto Lilienthal.

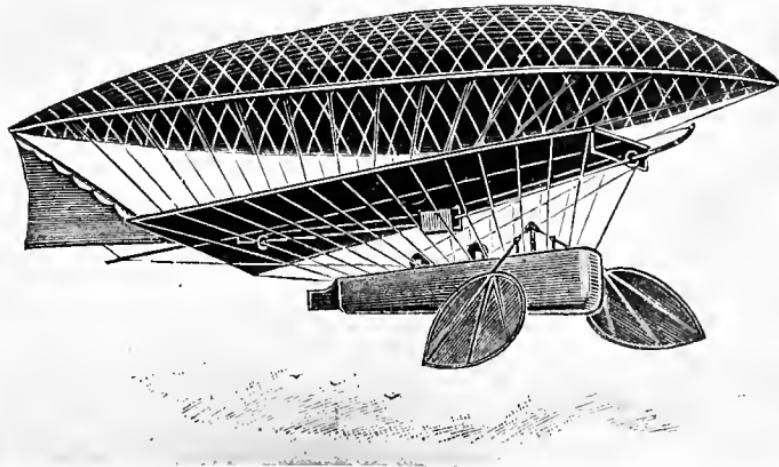
In 1806 the celebrated Lunardi, whom we have noticed in 1785 making his intrepid ascent in London,

died in a convent at Lisbon from consumption, doubtless contracted during his experiments and from undue exposure. Three years later, he was followed by Blanchard, who had made, all told, 66 ascents.

In 1811, James Sadler, accompanied by a friend, made a notable voyage. They ascended at Birmingham at 2.20 p.m., October 7th, and by 4 p.m. had covered 112 miles. When approaching Leicester, it was seen that the wind was bearing them due east to Market Deeping, but by descending to a lower altitude permeated by a different current, they reached the vicinity of Boston, where they descended. In the year following, Sadler made the first effort to cross the Irish Channel, starting from Belvedere House, Dublin. The attempt failed, although the aeronaut really did effect an aerial crossing, owing to his desire to alight near Liverpool. He was thrown into the sea and narrowly rescued from death. But what the father failed in, the son accomplished. Five years later, on June 22nd, Windham Sadler, who later lost his life in a balloon accident, successfully passed from Portobello Barracks, Dublin, and alighted at Holyhead. This feat appears to have suggested to many an investigation into the utility of balloons for conveying heavy burdens from place to place. But although Sir George Cayley headed a subscription list for the purpose of making experiments, nothing came of it in this instance. Indeed, for some years ballooning, having lost its novelty, ceased to cut any great figure in the scientific world, and few experiments in

the department of aerial navigation occur worth recording in Europe.

Two scientific investigators, Pauly and Egg, patented in 1815 a system of aerial conveyance which foreshadowed by many years a later popular theory. "Round bodies," they declared in their specifications, "being unfit for navigation through a fluid," a fish-



WORMS'S NAVIGABLE BALLOON.

shaped aerostat was employed by them. The net was attached to a frame round the lower part of the balloon, the latter being attached to the frame by a ribbon, so as to enable it to act as a parachute in the event of a bursting of the balloon. Wings are described composed of a head-piece playing backwards and forwards horizontally, and provided with feathers formed of silk, affixed to one side of a rod by means of whalebone. A curious feature of this apparatus.

was a barrel suspended below the car, which, when moved towards the tail, causes the head to rise and a contrary motion to be depressed, thus enabling the balloon to proceed upwards or downwards in an inclined direction. Water contained in this barrel might be used as ballast. Prior to an actual trial, so confident were the inventors of the soundness of their theory of flight by means of wings and a tail, that they declared, as Edison has recently declared, that the aerostat might be dispensed with.

Indeed, we find in many of the subsequent inventions for travelling in the air by means of wings or of screw-propeller, similar belief was entertained by their sponsors. The machine of Charles Stevens in 1860 very closely resembled the above described device of 1815.

Of the celebrated aeronauts of the second quarter of the last century, the name of Charles Green is among the earliest and best known. He made successfully a large number of ascents, solitary and with a companion. If Green did not succeed in accomplishing any important discovery, or in adding anything to aerostatic knowledge, yet his persistent and daring exploits in the heavens served to familiarise Englishmen with the navigation of the air, and therefore to popularise the science. In June, 1826, he ascended from Boston, Lincolnshire. "The balloon," he writes, "sailing due west, passed between Swineshead and Heckington, in a direct line for Grantham, when im-

mediately over Sir John Thorold's park, Boston, resembled a mass of rubbish covering about one acre ; on descending I entered another current that carried me towards Newark, and I alighted near Bottesford. The barometer showed my greatest altitude to have been $2\frac{1}{4}$ miles."

In the following July he made a nocturnal ascent from Vauxhall Gardens. "We kept the line of the Thames. Notwithstanding the cloudy state of the atmosphere, and being deprived of the light of the moon, I could distinctly see the earth. In Battersea and Wandsworth where the wheat was ready for cutting, it appeared like sheets spread on the ground ; the ploughed land was darker, and the trees and houses quite black ; bridges with gaslights appeared like rows of lamps resting on the water ; Battersea and Putney without them, like dark planks. By aid of Davy's safety lamp I could observe the barometer, and to prevent a higher descent than three-quarters of a mile, we descend at Richmond ; a horse-patrol was the only person on the spot, but on account of the dead calm, further assistance was not required.

One of the earliest of the English female balloonists, following the example of Madame Blanchard in France, was Mrs. Graham, who made her first ascent in 1824, a year after her husband's initial attempt. For a number of years following the pair were celebrated aeronauts, the lady frequently ascending alone. In 1836 she was accompanied by the Duke of Brunswick, and met with a somewhat serious accident in

her descent, which, however, did not deter her from further navigation.

A noted place at this time for balloon ascents was Vauxhall Gardens, the proprietors of which owned and maintained a large balloon, for the purpose of public exhibition. Their example has been followed by similar institutions of resort the world over to this day, and a balloon ascent has become a recognised feature of fairs, fêtes, circuses, and out-of-door exhibitions. We have seen the earliest instance of the connection between public jubilation and ballooning at the time of Napoleon's coronation, and this connection continued until a class of professional aeronauts sprung up throughout Europe and in America, whose remuneration naturally diminished with the growth of their numbers. Some of these men were educated and skilful, and of alert intelligence, and were consequently able to describe their sensations and the spectacle they witnessed, in an interesting manner. Others, and by far the greater number, could not do this, and were really to be classed with the race of trapezists and other daring aerial trick performers. But neither class added anything to the science; the problem of a dirigible balloon, which was, of course the goal aimed at by the philosophical aeronaut, remained as far off as ever.

Soon after the success of the locomotive engine on the Liverpool and Manchester Railway, an inventor named Artingstall contrived the first flying machine which was to be worked by steam. But the lack of

suitable equilibrium caused a want of success in the experiments.

The celebrated voyage of Green and Monck Mason from London to Weilburg bade fair to add much to a solution of the difficulty of how to control and direct the aerial machine, and it was certainly productive of hints for the greater safety of aeronauts in general.

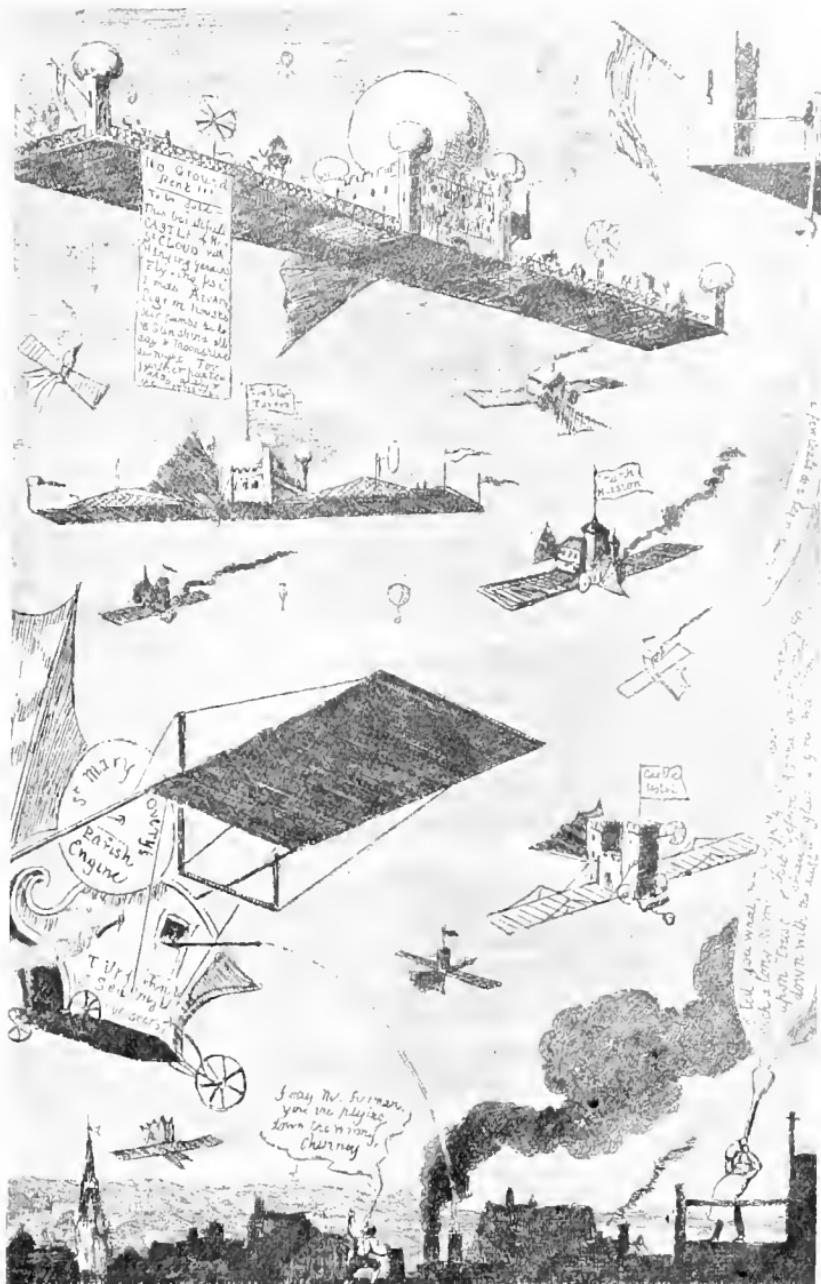
Robert Holland, a gentleman who had long cultivated a practical acquaintance with the art of aerostation, resolved to afford an opportunity for a full display and unequivocal determination of the merits of these discoveries, by undertaking, at his own expense, to fit out an expedition, under the guidance of Mr. Green, for the purpose and with the intention of starting from London and proceeding (in whatever direction the winds at the time prevailing might happen to convey them) to such a distance as would suffice to answer the ends for which the voyage was especially designed. In order to give the fullest effect to such an undertaking it was necessary to be provided with a balloon of size and structure superior to those employed upon ordinary occasions. Arrangements were accordingly entered into with Messrs. Gye and Hughes, the proprietors of Vauxhall Gardens, for the use of their large balloon, which they readily conceded, at the same time placing their premises at the disposal for the purposes of the ascent.

This balloon (says Mr. Monck Mason,* who

* I have thought it best to give Mason's narrative in a condensed form rather than to attempt a second-hand description of this memorable voyage.—E. S. V.

accompanied Green) had been but recently built for them by Mr. Green, and combined in its construction all that the art and experience of the first aeronaut of the age could contribute to its perfection. In shape it somewhat resembles a pear; its upright or polar diameter exceeding the transverse or equatorial by about one-sixth; a form and proportion admitted to be at the same time most consistent with elegance of appearance and most adapted to the wants and circumstances of aerostation. The silk of which it is formed is of the very best quality, spun, wove and dyed expressly for the purpose; the utmost breadth of the gores, which are alternately white and crimson, is about 44 inches; down the centre of each, and worked in the original fabric, runs a band or ridge of extra thickness, calculated to give additional strength to the texture of the material, and to arrest the progress of any rent or damage which might accidentally occur. The height of this enormous vessel is upwards of sixty feet; its breadth about fifty. When fully distended it is capable of containing rather more than 85,000 cubic feet of gas, and under ordinary circumstances is competent to raise about 4,000 pounds, including its own weight and that of its accessories, which alone may be reckoned at about one-fourth.

The car which appertains to this balloon is in proper keeping with its gigantic mate. It is composed of wicker-work, in the form of an oval, about nine feet in length and four in breadth. It is suspended by ten ropes to a hoop of six feet in diameter, and in thick-



From a Drawing by]

AERIAL FLIGHT IN THE FUTURE.

[GEORGE CRUIKSHANK.

ness a like number of inches, formed of two circles of ash, one within the other, forcibly bent by steam, and retained in their position as well as strengthened by a triple tier of cable which is enclosed between them. At either end of the car are two seats, fully capable of accommodating three persons each ; while across it in the middle, and somewhat raised, is extended a bench about a foot in width, which, besides aiding to preserve the form of the vehicle against its own weight or other external pressure, serves as a frame to support a windlass, intended for the purpose of raising or lowering the guide rope whenever it may be required. In addition to these conveniences, the entire bottom of the car was, on the present occasion, fitted with a cushion, intended to be used as a bed in case adverse circumstances, by keeping us at sea or otherwise, should have compelled us to prolong the duration of our voyage to such an extent as to make it necessary to repose.

All the preliminary arrangements being now completed, after several unavoidable delays, occasioned chiefly by the weather, the day of the departure was fixed for Monday, November 7th, 1836, and the process of inflation having been commenced at an early hour, everything was got ready for starting by one o'clock in the afternoon of the same day. As it had been resolved for special reasons that the ascent should not be made public, very few persons were present on the occasion within the precincts of the gardens. Outside, however, it was far different.

Attracted by the prospect of the balloon during the process of its inflation (no pains having been taken to conceal it from the public view), a large concourse of persons had been assembling since an early hour in the morning, and by the time that all was completed the multitude had already amounted to several thousands. So anxious, indeed, did they appear to witness the proceedings that serious apprehensions began to be entertained towards the conclusion lest the fences and palisades which enclosed the gardens might finally give way beneath the unwonted pressure of the numbers with which they were literally crowded.

The appearance which the balloon exhibited previous to the ascent was, in truth, no less interesting than strange. Provisions, which had been calculated for a fortnight's consumption in case of emergency: ballast to the amount of upwards of a ton in weight, disposed in bags of different sizes, duly registered and marked, together with an unusual supply of cordage, implements, and other accessories to an aerial excursion, occupied the bottom of the car; while all around the hoop and elsewhere hung cloaks, carpet-bags, barrels of wood and copper, speaking-trumpets, barometers, telescopes, lamps, wine-jars and spirit-flasks, with many other articles designed to serve the purposes of a voyage to regions where, once forgotten, nothing could be again supplied.

Amongst the various contrivances which the peculiar circumstances of the case had led us to adopt was a

machine for warming coffee and other liquors, in which the heat developed in the process of slackening quicklime was made to supersede the necessity of actual fire. This machine was found to answer the purpose perfectly well, although the dangers which it was intended to obviate are really not such as to require the aid of similar precautions. With that degree of prudence and attention which can at all times be commanded, no absolute peril need be apprehended from the employment of fire under proper restrictions. During the whole night we had a lamp burning constantly, nor did we at any time suffer anxiety on account of its presence, or perceive any occasion, even temporarily, to desire its extinction.

To provide against the inconveniences which we might have experienced subsequent to our descent in continuing our journey through a foreign country, we likewise took the precaution to furnish ourselves with passports directed to all parts of the Continent, specifying the peculiar nature of our voyage, and entitling us to exemption from the usual formalities of office.

Finally, we were also charged with a letter to His Majesty the King of Holland from Mr. May, His Majesty's Consul-General in London, which letter was put into the post-office at Coblenz on the evening of the day succeeding our departure.

Thus prepared and duly accoutred, at half-past one o'clock the balloon was dismissed from the ground, and rising gently under the influence of a moderate breeze bore speedily away towards the south-east, traversing

in her course the cultivated plains of Kent, and passing in succession nearly over the towns of Eltham, Bromley, Foot's Cray and others, whose variegated outlines beautifully diversified the rich landscape that lay beneath us. The weather was uncommonly fine for the time of year ; a few light clouds alone floated in the sky, and at least as useful and ornamental, served to indicate the existence of different currents at different altitudes : an information of which, it will be seen hereafter, we were enabled to avail ourselves with much effect.

Continuing in a south-easterly direction, at forty-eight past two we crossed the Medway at the distance of about six miles to the west of Rochester, and in little more than an hour after were in sight of the City of Canterbury, the lofty towers of its cathedral bearing distant about two miles, in an easterly direction. In honour of the mayor and inhabitants of that city, under whose patronage our celebrated pilot had twice before ascended, we lowerd a small parachute containing a letter addressed to the mayor and couched in such terms as our hurried passage would permit us to indite.

In a few minutes after we obtained our first view of the sea, brightening under the last rays of a setting sun, and occupying the extreme verge of the horizon, in the direction in which we were now rapidly advancing.

During the latter period of this part of our voyage the balloon, perhaps owing to the condensation occa-

sioned by the approaching shades of evening, had been gradually diminishing her altitude, and for some time past had continued so near the earth as to permit us, without much exertion, to carry on a conversation with such of the inhabitants as happened to be in our immediate vicinity. So close, indeed, were we at one time as to be able distinctly to observe a covey of partridges, which either our approach or some other equally dreaded apparition had dislodged from their resting-place, and sent to seek refuge on the borders of a wood which lay adjacent. A whole colony of rooks, alarmed, no doubt, by our formidable appearance, rose likewise in dismay, and after rending the air for miles round with their cries and vainly trying the protection of the neighbouring woods, finally dispersed, scattering themselves in every direction over the surface of the earth beneath.

Perhaps there is no situation conceivable from which the beauties of nature are seen to greater advantage or with more singular effect than that wherein the spectator is placed when, seated in a balloon, he happens by circumstances to be brought into closer approximation with the earth beneath. The increased distinctness of the different objects, the novel aspect under which a vertical examination presents them to the view, the isolated position occupied by the beholder, and above all the exquisite motion which, however undistinguishable from its absolute effects upon the person, exhibits to the eye the ever-varying charms of rapid flight, are all effects perceptible under no other circumstances—

and even denied to the aeronaut himself when occupying a higher range and indulging in a more extensive survey. It is not, in fact, the superior elevation and vast extent of prospect that under any circumstances constitute the real charms of such exhibitions, or contribute most to their enjoyment; and if we take the trouble carefully to examine the impressions which such scenes under such circumstances are wont to inspire, we shall find that, to whatever class they may at first appear to be referable, they are not nearly so much the offspring of pleasure as of surprise—of real critical delight as of that sort of gratification which is indebted to wonder and astonishment for its principal effect. To this conclusion I have been chiefly led by a consideration of the very beautiful appearance which the country presented, as under the influence of a gradual depression we slowly approached the ground, and for some time continued to skim along its surface at the slight elevation of a few hundred feet. The various objects, which, seen from on high, appeared like mimic representations of an ideal world, now gradually developed themselves, and assumed the character and aspect of reality. The forests and parks, no longer an indefinite mass of something green, opened at our approach, separating into individual trees, the leaves and branches of which seemed almost within our grasp as we hurried over them. The houses, roads, enclosures, canals, and other minuter indications of civilised society, before scarcely appreciable, now also began to display themselves in their true colours, adding the

charms of particular interest to that which was otherwise but imposing from its general effect ; while the most interesting features of all, the living forms of nature, till now altogether invisible, began to mingle in the scene, and gave life and expression to what was otherwise at best but an inanimate though brilliant landscape.

About this time the first opportunity occurred of showing how far it is possible for the skilful and experienced aeronaut to influence the course of his aerial vessel by availing himself of the advantages which circumstances frequently place at his disposal. Shortly after we had lost sight of the city of Canterbury a considerable deviation appeared to have taken place in the direction of our route. Instead of pursuing our former line of south by east, which was that of the upper current, by means of which we had hitherto advanced, it became apparent that we were now rapidly bearing away upon one which tended considerably to the northward, and which, had we continued to remain within the limits of its influence, would have shortly brought us to sea in the direction of the North Fore-land. As it had all along been an object to proceed as near to Paris as circumstances would permit (the proprietors of the balloon having contemplated making an ascent from Paris, and Mr. Holland having undertaken to transfer the balloon thither, it became a considera-tion with us not to increase our distance from that capital more than was consistent with the main object of the expedition), we resolved to recover as soon as

possible the advantages which a superior current had hitherto afforded us, and accordingly rose to resume a station upon our previous level. Nothing could exceed the beauty of this manœuvre, or the success with which the balloon acknowledged the influence of her former associate. Scarcely had the superfluous burden been discharged proportioned to the effect required, when slowly she arose, and sweeping majestically round the horizon, obedient to the double impulse of her increasing elevation and the gradual change of current, brought us successively in sight of all those objects which we had shortly before left retiring behind us, and in a few minutes placed us almost vertically over the Castle of Dover, in the exact line for crossing the straits between that town and Calais, where it is confined within its narrowest limits.

Up to the present moment nothing had appeared calculated to confer particular distinction upon our enterprise, or to awaken the impression that what we had undertaken differed in any respect from the usual class of such excursions. The case, however, was now shortly to be changed ; a new and untried element was about to enter upon the scene, producing new relations and requiring the exercise of new resources. The knowledge that whenever we might feel inclined it was in our power to terminate our voyage by descent (which gives such a sense of security to all excursions over land) was about to yield to the conviction that, no matter how urgent the desire, how imperious the necessity, *that* expedient would in future be withheld

from us until it had pleased Providence to convey us to new regions, and afford us once more the circumstances of a solid resting place. When or where that might be, was a question as doubtful as the winds by which alone it could be determined ; nor was it the smallest of the many charms peculiar to our situation, that it was, and must for some time remain, a matter of the most incertitude what portion of the globe was next destined to receive us. Confident, however, in our own resources, I may safely assert that it was to us a matter of the most perfect indifference in what manner that uncertainty should be decided ; and I feel convinced that I but speak the sentiments of the whole party when I declare that not a single particle of anxiety as to our own personal safety for a moment disturbed the ardent desire we all felt to push to a creditable bearing the enterprise in which we were embarked.

The first impression which this event was calculated to convey was that the wind had changed, and that we were in the act of returning to the shores we had so shortly before abandoned. A glance or two, however, served to show us the fallacy of this impression ; the well-known lights of Calais and the neighbouring shores were already glittering beneath us ; the barrier of clouds which I have before mentioned as starting up so abruptly in our path as abruptly terminated ; and the whole adjacent coast of France, variegated with lights, and rife with all the nocturnal signs of population, burst at once upon our view. We had, in fact,

crossed the sea ; and in the short space of about one hour from the time we had quitted the shores of England were floating tranquilly, though rapidly, above those of our Gallic neighbour.

It was exactly fifty minutes past five when we had thoroughly completed this *träject* ; the point at which we first crossed the French shore bearing distant about two miles to the westward of the main body of the lights of Calais, our altitude at the time being somewhat about 3,000 feet above the level of the ocean. As it was now perfectly dark we lowered a Bengal light, at the end of a long cord, in order to signify our presence to the inhabitants below : shortly after, we had the satisfaction to hear the beating of drums, but whether on our account, or merely in performance of the usual routine of military duty, we were not at the time exactly able to determine.

It would be very difficult, if not impossible, to convey to the minds of the uninitiated any adequate idea of the stupendous effect which such an exhibition, under all its concomitant peculiarities, was calculated to create. That we were, by such a mode of conveyance, amid the vast solitude of the skies, in the dead of night, unknown and unnoticed, secretly and silently reviewing kingdoms, exploring territories, and surveying cities, in such rapid succession as scarcely to afford time for criticism or conjecture, was in itself a consideration sufficient to give sublimity to far less interesting scenes than those which formed the subject of our present contemplations. If to this be added the

uncertainty that from henceforward began to pervade the whole of our course—an uncertainty that every moment increased as we proceeded deeper into the shades of night, and became further removed from those landmarks to which we might have referred in aid of our conjectures, clothing everything with the dark mantle of mystery, and leaving us in doubt, more perplexing even than ignorance, as to where we were, whither we were proceeding, and what were the objects that so much attracted our attention—some faint idea may be formed of the peculiarity of our situation and of the impressions to which it naturally gave rise.

In this manner, and under the influence of these sentiments, did we traverse with rapid strides a large and interesting portion of the European Continent, embracing within our horizon an immense succession of towns and villages, whereof those which occurred during the earlier part of the night the presence of their artificial illumination alone enabled us to distinguish.

For the benefit of such lovers of good cheer as may in future be tempted to prove the pleasure of aerostation, it may be as well to observe that it is not all liquors that can be conveniently employed upon such occasions. Champagne, for instance, and bottled porter, cider, soda-water, and all those which are generally termed “up in the bottle,” however anomalous it may appear, are by no means adapted for aerial excursions; their natural tendency to flying being so much accelerated by the diminished pressure

it is the consequence of their elevation that they invariably fly off altogether almost as soon as they have quitted the ground.

The perfect correctness with which every line of street was marked out by its particular line of fires, the forms and positions of the more important features of the city—the theatres and squares, the markets and public buildings—indicated by the presence of the larger and more irregular accumulation of lights, added to the faint murmur of a busy population still actively engaged in the pursuits of pleasure, or the avocations of game, all together combined to form a picture which for singularity and effect could never have been conceived. This was the city of Liège, remarkable from the extensive iron works, which, abounding in its neighbourhood, occasioned the peculiar appearance already described, and at the time led to that conjecture concerning its identity, the truth of which a subsequent inquiry enabled us to confirm.

From this period of our voyage until the dawning of the following day the record of our adventures becomes tinged with the obscurity of night. The face of nature completely excluded from our view, except when circumstances occasionally brought us into nearer contact with the earth, all our observations during the above period are necessarily confined to a register of incidents and sensations, mingled with vague conjectures and clouded with the mystery wherewith darkness and uncertainty were destined to involve so large a portion of the remainder of our expedition.

The moon, which we might have looked up to for companionship and assistance, had she been present, was nowhere to be seen. The sky, at all times darker when viewed from an elevation than it appears to those inhabiting the lower regions of the earth, seemed almost black with the intensity of night; while, by contrast, no doubt, and the absence of intervening vapours, the stars, redoubled in their lustre, shone like sparks of the whitest silver scattered upon the jetty dome around us. Occasionally faint flashes of lightning, proceeding chiefly from the northern hemisphere, would for an instant illuminate the horizon, and after disclosing a transient prospect of the adjacent country, suddenly subside, leaving us involved in more than our original obscurity.

As soon as we had come to this determination, all preparations were speedily commenced for the descent; the guide-rope was hauled in—an operation of much labour, owing to the bad construction and imperfect action of the windlass—the grapnel and cable lowered, and everything got ready that we might be able to avail ourselves of the first and fittest opportunity that might occur. To this intent, likewise, we quitted our exalted station, and sought a more humble and appropriate level, along which we continued to range for some time, and to a considerable distance, the yet early hours of the day deterring us from completing the descent, in fear of not obtaining that ready assistance from the inhabitants which is always the main object of the aeronaut, if possible, to secure.

As the mists of the night began to clear away from the surface of the soil, we were delighted to perceive a country intersected with roads, dotted with villages, and enlivened with all the signs of an abundant and industrious population. The snowy covering which so lately chilled us with its forbidding aspect had now disappeared, except a few patches which still lingered in the crevices, or lay spread in the sheltered recesses of the numerous hills by which the surrounding neighbourhood was particularly distinguished. On the summit of one of these an isolated edifice of considerable magnitude and venerable antiquity appeared, just breaking through the vapours that yet partially concealed the morning landscape. Seated upon the very point of the eminence, it seemed like some ancient baronial castle overlooking the prospect and extending its protection to a cluster of humbler dwellings that straggled around its base. One or two towns, likewise, of superior pretensions were distinctly to be seen, giving promise of accommodation and advantages, which, in our present emergencies and under our present convictions, were not to be neglected. Accordingly, having pitched upon the spot most proper for the purpose, the valve was opened and we commenced our descent.

The place so selected was a small grassy vale, a quarter of a mile wide, embosomed in hills, whose sides and summits were completely enveloped in trees. Beyond this, on the opposite side, lay another valley of the same description; the only one visible for many

miles where we could conveniently effect our landing, an endless succession of forest scenery completing the landscape in the direction in which we should have had to proceed. Into the former of these we now precipitated our descent with the design of alighting, if possible, in the centre, clear of the woods that enclosed it on all sides. In these hopes we were, however, disappointed; the wind, suddenly increasing as we approached the ground, so much accelerated the onward course of the balloon, that before the grapnel could take effectual hold of the soil we had passed the middle of the valley, and, sweeping rapidly over the ground, were borne close against the wooded declivity that flanked its eastern termination. To discharge a sufficiency of ballast to raise the balloon, and carry her clear of the impending danger, was the natural remedy. An unexpected obstacle to this operation here again presented itself; the sand which forms the ballast, frozen during the night into a solid block of stone, refused to quit the bag in the proportion required, and no time remained to search for one more suited to the occasion. Not a moment was, in fact, to be lost; the valley was past, and the branches of the trees that clothed the opposing precipice were already within a few feet of the balloon; the grapnel continued to drag, and no chance appeared of arresting her progress onward. In this emergency one alternative alone remained, and the sack itself, with all its contents, to the amount of 56 pounds in weight, were at once consigned to the earth. In a moment the balloon, lightened of so

large a portion of her burden, had sprung up above a 1,000 feet, and, clearing the mountain at a bound, was soon in rapid progress to the realms above. To counteract the consequence of this sudden accession of power, and avoid being carried beyond the reach of the second valley, which we have already described as the only other available spot for our descent, the valve was again opened, and issue given to a large quantity of gas, sufficient, as was calculated, to check the course of the balloon in time to enable us to attain the point to which all our views were now directed.

While in this situation we perceived, standing in a path in the wood, two females, the first inhabitants we had noticed, lost in astonishment and seemingly petrified with gazing upon so astounding an apparition. It was in vain we addressed them with a speaking-trumpet, in the hopes of securing the assistance of some of the male population, which we conjectured could not be far off. The sound of our voices proceeding from such an altitude, and invested with such an unearthly character, only augmented their astonishment and added to their fears; they fled incontinently without waiting further parley and sought the shelter of the neighbouring coverts.

As soon as the descent was completed and the power of the balloon sufficiently crippled to permit one of the party to quit the car, the inhabitants, who had hitherto stood aloof, regarding our manœuvres from behind the trees, began to flock in from all quarters, eyeing at first our movements with considerable suspicion, and

not seldom looking up in the direction from which we had just alighted, in the expectation, no doubt, of witnessing a repetition of this, to them, inexplicable phenomenon.

A few words in German, however, served to dissipate their fears and secure their services. The first question, "Where are we?" was speedily answered, "In the Duchy of Nassau, about two leagues from the town of Weilburg." The second was theirs, "Where do you come from?" "From London, which we left yesterday evening." Their astonishment at this declaration may be easily conceived. The fact, however, was not to be disputed. What they had seen was to the full as marvellous as anything we might choose to relate, and certainly enough to entitle us to consideration and command respect.

It was half-past seven o'clock when this occurrence took place and our descent was fairly said to be completed. The duration of our voyage may therefore be calculated at exactly eighteen hours.

Thus ended an expedition which, whether we regard the extent of country it passed over, the time wherein it was performed, or the result of the experiment for the sake of which it was undertaken, may fairly claim to be considered among the most interesting and important that have hitherto proceeded from the same source. Starting from London, and traversing the sea, which mere accident alone prevented from forming a more important feature in the route, in the short

space of eighteen hours was performed a voyage which, including those deviations we have since been enabled to ascertain, rather exceeds than falls short of an extent of 500 British miles.

It would be endless as well as useless to enumerate all the places of name and notoriety, which a subsequent examination of the map, aided by the reports received at different stations by the way, showed the aerial travellers to have either passed over or approached at some period of this extraordinary peregrination: a considerable portion of five kingdoms, England, France, Belgium, Prussian Germany, and the Duchy of Nassau; a long succession of cities, including London, Rochester, Canterbury, Dover, Calais, Cassel, Ypres, Courtray, Lille, Oudenarde, Tournay, Ath, Brussels, with the renowned fields of Waterloo and Jemmapes, Namur, Liège, Spa, Malmedy, Coblenz, and a whole host of intermediate villages of minor note, were all brought within the compass of an horizon which the superior elevation, and the various aberrations experienced, enabled the voyagers to extend far beyond what might be expected from a mere consideration of the line connecting the two extremities of their route.

The famous humorist, Albert Smith, in one of his effusions, thus commemorated the successful aeronaut who had made the foregoing voyage:

Air—"The Ivy Green."

Oh! a daring man is the Aerial Green
As he rises above the wall

Of the turf'y Cremorne, or for nothing is seen
From the road beside old Vauxhall !
How bleak soe'er the wind may feel
Or dark the night may keep,
He lights a match of his firework wheel,
Though all below may sleep.
Creeping where nobody else has been,
A daring man is the Aerial Green !

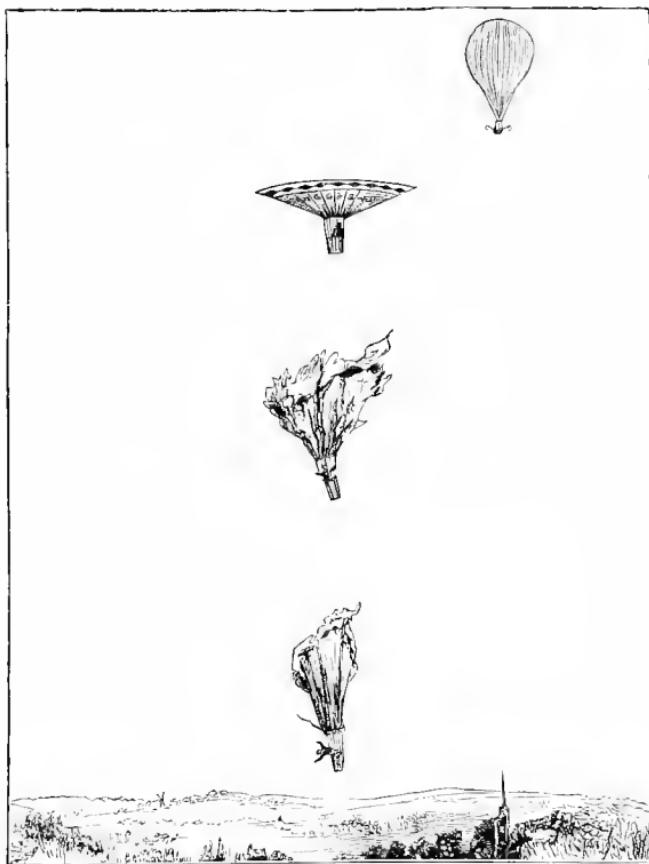
CHAPTER IV.

SINCE Garnerin's experiments in England in 1802 no other aeronaut had employed the parachute in this country. Indeed its usefulness did not appear manifest even on the Continent, for, with the exception of Kuparento, a Polish aeronaut, who managed to effect his escape from a burning balloon, there is no instance of its having been employed to advantage.

In 1837, Henry Cocking, who had devoted many years to aerostatics and was particularly interested in the parachute, constructed an improvement on Garnerin's contrivance after his own theories, and announced that he would publicly descend with it from Green's balloon, the one which had made the journey to Nassau. His invention was open to so many objections that an attempt was made to dissuade him from carrying out his purpose. Monck Mason, in particular, on the day preceding the venture, published a lengthy letter in the *Morning Herald* showing in the most conclusive manner that Cocking's calculations were faulty, and predicting failure.

“With regard, therefore,” he wrote in conclusion, “to the employment of the parachute in question, or, indeed,

of any other that may be constructed on the same principle, I have no hesitation in predicting that one of two events must inevitably take place, according to the special nature of the defect which may happen to be



COCKING'S FATAL DESCENT.

predominant. Either it will come to the ground with a degree of force we have before shown to be incompatible with the final preservation of the individual; or, should it be attempted to make it sufficiently light to

resist this conclusion, it must give way beneath the undue exercise of the forces it will necessarily develop in the descent."

Cocking, however, persisted in his design. It is not improbable, in spite of the criticisms directed against his particular parachute, that he would have succeeded had it been made of stronger materials. Whereas Garnerin's contrivance had been in the form of an umbrella, closed at the moment of descent, and then expanded by the force of the atmosphere, this might be compared to an umbrella reversed, the cavity containing the air being uppermost with a view of preserving oscillation. The inventor, prior to the ascent, in company with Green, expressed great confidence and declared that the greatest peril of any would attend the balloon when suddenly relieved of the weight (about 500 lbs.) of himself and the parachute.

The ascent took place at six o'clock. A Mr. Underwood followed on horseback the direction of the balloon. He saw Green sever the cord which bound the parachute, which thus left to itself, descended with the utmost rapidity, accompanied by sickening oscillations. These continuing, the suspended basket containing the unhappy man broke loose and precipitated him into a field near Lee, Blackheath. He was literally dashed to fragments. Yet some years later the American aeronaut, Wise, experimented at Philadelphia both a Garnerin and a Cocking parachute, and found the latter to work very satisfactorily. Even with the defect in the upper hoop, which caused his parachute to collapse,

Wise thought Cocking would have descended without very serious consequences, by the friction of this vast surface through the atmosphere in a collapsed state, had the fated aeronaut not lost his presence of mind, which caused him to receive the shock all at once. Some of Wise's ascents were highly interesting and their number and daring character justified his title to be considered the foremost American aeronaut. On one occasion, he was overtaken by a whirlwind, which enveloped his entire machine in a cloud of dust, sand, and dry vegetable matter. "This," he writes, "so tossed about the aerial ship that I was obliged to take refuge in the bottom of the car, the better to maintain my centre of gravity. After being thus swung for a minute or two, and carried up to south-westward for a considerable distance for so short a time, the whirlwind dispersed and I began to descend again.

"Having before this seen islands of smoke ascending from the pines to the south-east of me, which I then took for collieries, I now found it to be the pines on fire, and the balloon fast descending right into it. Knowing the consequence of such a catastrophe, from sad experience, the ballast yet remaining in the car was quickly disposed of. Finding this not to check the balloon sufficiently from falling into the fiery desert below, the speaking-trumpet and air-bottles had to follow, which fortunately enabled me to cross the conflagration."

It was a narrow escape. Another ascent in August, 1836, or rather descent, was even more exciting. We will let Mr. Wise relate it in his own words :

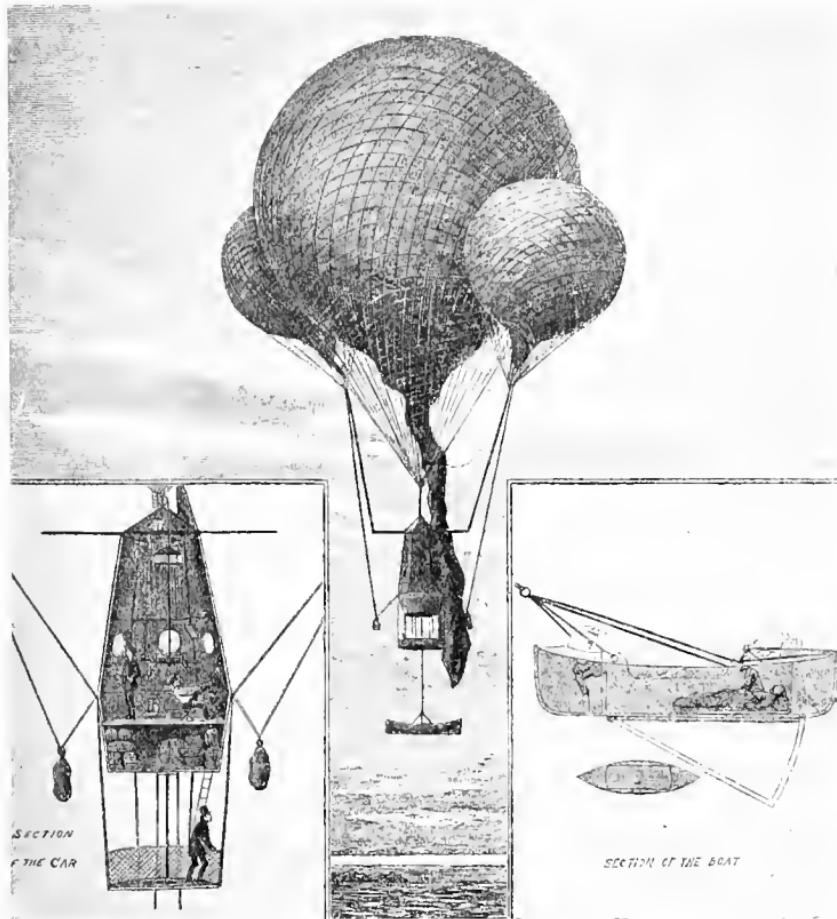
At a few minutes before two o'clock the balloon was detached from terra firma. I had with me two parachutes containing animals—one a cat, the other a dog; and as the balloon approached a dense body of thunder-clouds, some vivid flashings of lightning accompanied by violent peals of thunder greeted my upward passage. This gave the first part of my voyage a terrific, but grand and imposing, appearance. It seemed to me as though Heaven's artillery were celebrating the occasion of the progress of the new-born science, and it inspired me with a determination to try the new experiment of atmospheric resistance as a means of safe descent in the event of explosion of the balloon at great heights. As soon as an altitude of about 2,000 feet was attained, the conical parachute with its occupant (this was one on Cocking's plan) was detached, which landed in safety near Lafayette College, at the head of the town. Soon after this the balloon attained an altitude of about 4,000 feet, at which point the oiled-silk parachute, with its occupant, was detached. This was to foreshadow the effect of the experiment of exploding the balloon, and was so contrived as to have an apparent disadvantage compared with that of the large machine. This small one was nothing more than a balloon in a collapsed state. When thrown overboard it fell some distance before it expanded completely, and after it had expanded, it fell with a very irregular, vibratory motion, which was not the case with the other one. Upon this I concluded, however, that the experiment would not be hazardous, if disagreeable. I was

also assured from my experience that a balloon in a flaccid state, or only partly so, would invert, that is, the lower part cave into the upper part and assume a hemispherical shape in a rapid descent.

When an altitude of about 13,000 feet was attained, the balloon became fearfully expanded—to its utmost tension—and having but an inch-diameter tube in the neck, the gas began to issue through this orifice with considerable noise. I would here observe, however, that any slight noise, occurring in so perfectly quiet a place, as is that of a balloon a mile or two above the earth, makes apparently a great noise. At this period of the voyage it was evident that, unless gas were speedily let off, the balloon must burst from expansion; for she was still rising, and the explosion cord, being tied rather short, had also become tense, and must evidently be tending towards a rupture at the points where it passed through the balloon.

At this critical moment I became somewhat excited, and as I looked over the side of my car I observed the sparkling coruscations of lightning springing from cloud to cloud a mile beneath me, as the thunder-storm was passing its last remnants below. The storm was moving from S.W. to N.E., and the balloon was sailing from N.W. to S.E., passing New Village and Asbury, and I could now see the earth in that direction. I took out my watch, noted on my log-book the time—twenty minutes past two—and as I was about returning it to my pocket, thinking at the time whether it were not best to relieve the explosion rope, discharge

ballast, and abandon for the present the idea of this experiment, *the balloon exploded!* Although my confidence in the success of the contrivance never for a moment forsook me, I must admit that it was a moment of awful suspense. The gas rushed from the rupture in the top of the balloon with a tempestuous noise, and in less than ten seconds not a particle of hydrogen remained in it. The descent at first was rapid, and accompanied with a fearfully moaning noise, caused by the air rushing through the network and the gas escaping from above. In another moment I felt a slight shock. Looking up to see what caused it, I discovered that the balloon was canting over, being nicely doubled in, the lower half into the upper ; it had fallen, condensing the column of air upon which it was falling until it had arrived at a point where it was so dense that the force of the whole weight pressing down on it was arrested, which caused the parachute to tilt over. The weight of the car, however, countervailed the tilted tendency, giving it an oscillating motion, which it retained until it reached the earth. The velocities of these zig-zag descents were marked by corresponding notes of the wind as it whistled through the rigging of the balloon. On reaching the point where the lower current of air traversed the upper, another and more violent shock than the first was the result. From this point the oscillations became more severe, each one causing a sensation in me similar to that which a person experiences when dreaming that he is falling.



WISE'S TRANSATLANTIC BALLOON.

The wind from the south-west drifted the machine several miles in its direction before it fell to the earth. As I neared terra firma all the ballast was thrown overboard; but when I struck it was with a violent concussion, for the machine was just then at its maximum velocity of descent. The car struck the earth obliquely, and I was thrown about ten feet forward from it. The balloon had fallen along side of me, and so complete was the collapse where the lower part had doubled into the upper, that it was with difficulty separated again. The car had turned bottom upwards, and there I stood congratulating myself on the result of this exciting experiment—the perspiration rolling down my forehead in profusion, for the atmosphere below felt oppressive. The landing was made on the farm of Mr. Elijah Warne, about ten miles from Easton. Before many minutes had elapsed after this descent I had resolved to repeat this experiment from Philadelphia at the first opportunity.

Since this experiment balloons have exploded while aeronauts have been aloft with them, and in no instance have their persons been seriously injured; but every newspaper and periodical account set them down as miraculous escapes. The miracle is always in the height from which the machine falls to the earth, the resistance that the atmosphere must present to it being never hardly taken into account. We might as well call the descent of the flying squirrel from the high forest tree to the earth without sustaining any bodily

injury a miracle; for its surface compared to its weight is not in a greater ratio than is the weight compared to the surface of a common sized balloon, whatever shape the latter can assume. This is a principle in aeronautics which has never yet been duly considered, although a very ingenuous mathematical deduction upon the descent of parachutes has been given in this work. Meteorological and astronomical deductions are yet much to be facilitated by the science and practice of aeronautics. There are things in its philosophy that men have not yet dreamed of. There are sublimities in its practice that the world has not yet been fully prepared to realize.

Although the principle of atmospheric resistance is a self-evident thing, and its application to a safe descent from great heights has been demonstrated, there are yet very few persons who are willing to believe it so well established as to entitle it to be practised with impunity.

The public mind had now, by the large number of successful aerial voyages of considerable length, been prepared for a proposition whose very announcement would have staggered the previous generation. The aeronaut, Charles Green, in 1840, expressed himself as ready to undertake a journey in a balloon across the Atlantic Ocean. He gave it out publicly as his opinion that the obstacles divided themselves naturally into two classes; those, namely, which regard the maintenance of the power of the balloon throughout the period for which its services are likely to be required,

and those which arose from a difficulty of governing the proper direction of her course. These would be the ordinary leakage of gas, and the difficulty of making the balloon retain the same atmospheric elevation, without which the normal leakage is increased by the expansion and contraction of the air. The constant loss of ballast, with no means of repletion, was also a difficulty. Green proposed to neutralise the adverse conditions by extending a cylinder or windlass across the hoop (to which the netting covering the upper part of the balloon is made fast) over which would pass a strong rope 2,000 feet in length, the extremity suspended in the air. To the end of this rope would be fastened a number of small waterproof canvas bags, fashioned in such a manner as when drawn through the water to admit the entrance of the fluid but oppose its return. At stated intervals along the rope would be strung hollow copper floats to support it in the water. With such a contrivance for obtaining liquid ballast at will this ingenious aeronaut thought it would be possible to maintain the balloon at an equable elevation for a period of three months if necessary. There having been much speculation from the first discovery of aerostation, regarding the probable condition of that portion of the atmosphere beyond the reach of our ordinary observations, Green announced that he had discovered a uniformity in the direction of the air currents so marked as to cause it to be regarded as a law. "Under whatever circumstances I make my ascent, however contrary the

direction of the winds below, I uniformly found that at a certain elevation, varying occasionally, but always within 10,000 feet of the earth, *a current from the west or rather from the north of west, invariably prevailed.*" For this reason he fixed upon America rather than England as the point from whence the attempt should be made to traverse the Atlantic soon afterwards.

However, while waiting for some liberal patron of the arts to come forward and equip him with the means to undertake his transatlantic enterprise, Green made an aerial journey which nearly resulted in his death and that of a gentleman named Macdonnell, who had ventured to make the ascent in his company. When over the Essex side of the Thames, where there were few woods or orchards, the aeronaut decided to lower the balloon. As they descended a grappling iron was let down to the distance of 140 feet towards the earth. Green cautioned his companion to take firm hold of a rope fastened across the wicker car. Macdonnell had just obeyed when there came a terrific shock. "We were going," he said afterwards, "at the rate of at least sixty miles an hour, and our anchor caught in the side of a dike, and, owing to the extreme speed with which we were travelling, tore its way through the hoop to which it was fastened, and coming in contact with the car as it snapped, completely upset it, so that I and Mr. Green were turned topsy-turvy, with our heads towards the ground. The rope which was passed across the car alone prevented our falling out,

though so complete was the upset that most of the contents of the car, such as the ballast, etc., as well as my own hat, dropped to the earth. In another moment the car righted, and the balloon, thus freed from every check, descended, dashing us with terrific force against the ground."

But this, so far from being the end, was but the beginning of a thrilling adventure, for the balloon now started to roll with the two men across country at break-neck speed. A small river was reached through which they were hurried, half buried in the water, to the opposite bank, over which the car bounded like a tennis-ball. Then they found themselves dragged through long stretches of marsh and osiers towards a high mound which loomed up at hand and threatened their destruction. "But onwards, still onwards, the terrible demon to which we had linked ourselves held its way. Ere long we were dashed against the mound and then carried over it right upon a strong paling that lay at the other side. But nothing could withstand our impetuosity, and we burst through the oaken timbers as though they were cobwebs." But Green had sustained severe internal injuries in the concussion, although the car still held its course across a level country. Large herds of cattle fled panic-stricken before it. At length Macdonnell seized a moment when the balloon slackened its pace to throw himself from the car. But, apprehensive that, lacking his weight the balloon might rise and carry his injured companion on a second journey into space, the other

held on the rope, although it cut through the flesh nearly to the bone, until a countryman came to his assistance and rescued Green from the car. They had crossed the Thames four times and gone twenty miles in less than twenty minutes. The catastrophe, which, however, did not prove fatal, or even serious, despite the newspaper reports, was wholly owing to the violence of the wind. The experiences of the wicker car illustrated in a new form the "fact in natural philosophy that a comparatively soft body when in very rapid motion will force itself through a hard one without itself suffering material injury."

A year or two elapsed without any substantial progress on Green's part to carry out his intention of crossing the Atlantic. Meanwhile the project had been embraced by the redoubtable Wise, as will appear from the American newspapers of that day.

"Although," remarked one journal, "the scheme may seem somewhat Quixotic, we have no doubt Mr. Wise possesses the nerve to attempt, and, we believe, has the ability to carry it out. Our New York friends, therefore, must not be astonished to see our intelligent and scientific aeronaut arrive in their city next year (1844) with his large balloon, and take his departure thence for the regions of the Old World. What a sensation he would produce in England as, coming along the Channel, he made preparations to settle down his aerial chariot in the heart of London; or, missing this, suppose him dropping in upon the Frenchmen at Paris, or Calais, or Bordeaux; or, going further

still, suppose him wafted into Constantinople, dashing down unceremoniously and without notice to the Sublime Porte!"

Wise himself wrote as follows to the American Press:—

"As it is my intention to make a trip across the Atlantic ocean with a balloon in the summer of 1844, and as the descent or landing of balloons, in my experience, has almost universally created unnecessary alarm and consternation to the people near by, I therefore give this general notice to the seafaring community of all climes, that should they, during any time henceforth, chance to be in the vicinity of a balloon, either on the ocean or in the atmosphere, they need not be under fearful apprehensions, but endeavour to give aid to its adventurer. It must not be inferred from this that its success is considered improbable, but merely to be prepared for all emergencies."

Wise's ocean-travelling balloon was designed to be 100 feet in diameter, which would give it an ascending power of 20,000 lbs. ; and a seaworthy boat was to be used for the car, in case of accident, and the crew was to consist of three persons—viz., an aeronaut, a sea-navigator, and a scientific landsman. The public announcement terminated in the following quaint and characteristic fashion :

"Therefore, the people of Europe, Africa, Asia, and all other parts, on the ocean or elsewhere, who have

never seen a balloon, will bear in mind that it is a large globe of cloth, ensconced in a net-work with a sloop hanging underneath it, containing the latest news from the United States, and crew of the world's obedient servant, JOHN WISE."

The American aeronaut, like Green, lacking funds, petitioned Congress for an appropriation, but being without political influence and his scheme being regarded as chimerical the petition was shelved, and the project therefore came to nothing.

Indeed, by this time, balloons, considered as means of certain aerial navigation, were held in the most enlightened scientific quarters with distrust, and it was even declared that Montgolfier's invention had contributed nothing to a solution of the problem of navigating the air for practical purposes. This being an opinion widely entertained, it is not surprising that numerous inventors were now seen to be returning to the class of experiments pursued prior to the balloon's invention half a century before. The experiments of Blanchard, of Guyton de Morveau, and other aeronauts showed that oars could only slightly affect a balloon in a perfect calm. Monge, a member of the French Academy and the inventor of descriptive geometry in the very year of Montgolfier's triumph, proposed a method of directing aerostats. As many as twenty-five spherical balloons were to be attached to each other, like beads upon a necklace, so that they could either lie in a straight line or bend in all directions. Two aeronauts might be

attached in a car to each, and receive their orders by signals from the captain for ascending or descending. In such manner it was imagined that the movement of a serpent in the water would be imitated. Albeit the singular plan was never executed. At a little later period, General Meusnier, of the French Engineers, proposed a spherical balloon of ordinary dimensions, with an exterior cover, to contain compressed air. By means of a pump this was to be filled or emptied, thereby raising or lowering independent of valve or ballast. In order to effect horizontal movement, this inventor relied upon atmospheric currents, and so devised a plan to enable the aeronaut to move from one current to the other by means of cross sails of windmill pattern. These could be contracted or expanded with all the power at the aeronaut's command, and would suffice for a slow, but effective, propulsion of the machine. Between the date of this proposition and 1843, when Green and Wise were scheming to cross the Atlantic, there were numerous endeavours to discover a means to render the ordinary balloon dirigible. So far as we have noticed there had been few, hardly any, improvements on the balloon since the time of Charles, and those improvements were little to the real purpose desired. It now came to be realised that balloons of spherical form can not be guided at all. "It is only possible for them to turn on their own pivots; their progress is by fits and starts, swaying backwards and forwards. If a guidable aerostat was ever to be made, it must be ship-like, with wood and metal in its construction—a

serious attempt, in short, involving some considerable outlay."

Nothing new seems to have been attempted in aero-station until 1834, when an ex-colonel of the French army, named Lennox, believing, like so many since, that he had discovered the solution of the great problem, announced a practical experiment of his invention. Lennox's machine measured about 150 feet in length by about 45 feet high. The car was 70 feet long, and was intended to convey sixteen persons, the covering of the balloon being of impermeable silk, which would retain the hydrogen for a fortnight. The method of ascent and guidance consisted of oars, with a rudder, and a balloon of natatory bladder, as in the project of General Meusnier. The description of the new machine had excited the public curiosity to such an extent that on the day of the ascent, an enormous crowd gathered in the Champ de Mars, as they had previously gathered on like occasions a generation or two before. The balloon was transported to the spot from the factory ; during this short journey, any intelligent person who cast even a hasty glance upon it could have predicted the result. Far from possessing an ascensional force sufficient to raise sixteen persons, it was with difficulty that it sustained itself. In fact, at the moment when the signal was given for the ascent, it was found impossible to induce it to quit the soil. As in all unhappy public enterprises of this description, at least in those days, the inventor was hooted, buffeted, and insulted, and his machine was torn into fragments under his eyes by the



HENSON'S AERIAL PLANE (1842).

infuriated mob. The principle, however, of Lennox's apparatus was good, and if the balloon had been more judiciously constructed the result might have been far different. The inventor had staked his all on the trial, and the disaster utterly ruined him.

It was not until nine years later, when Henson's aerial carriage became the reigning sensation of the hour, that a considerable stride towards a practical solution of the difficulty seemed to be taken.

The earliest experimentors probably observed with envy and astonishment the performance of the soaring species of birds such as the eagle, the vulture and the hawk, which sail at will in every direction upon rigidly extended wings. But the majority of the flapping birds were so much more familiar and easily observed that they became the favourite model for inventors. The notion of obtaining sustaining power from the air with a fixed instead of a vibrating surface did not occur to any of them. It was in the year 1842 that the first "aeroplane" was devised. The aeroplane is, in brief, a thin fixed surface, slightly inclined to the line of motion and deriving its support from the upward action of the air pressure due to the speed. Motion is derived from some separate propelling arrangement.

"If," said the inventor, Henson, "any light and flat, or nearly flat, article be projected or thrown edgeways in a slightly inclined position, the same will rise on the air till the force exerted is expended, when the article so thrown or projected will descend; and it will readily be conceived that if the article possessed in itself a

continuous power or force equal to that used in throwing or projecting it, the article would continue to ascend so long as the forward part of the surface was upwards in respect to its hinder part, and that such article, when the power was stopped, or when the inclination was recovered, would descend by gravity only if the power was stopped, or by gravity, aided by the force of the power contained in the article, if the power be continued, thus imitating the flight of a bird."

From the foregoing it is evident that Henson had a great appreciation of the properties of what is now termed the "aeroplane." The machine to which, in 1842, he gave his name was an aeroplane propelled forward at a suitable inclination and speed, and serving as a support on the air for itself and the connecting parts. The car, or vessel, was built with a view to strength and lightness, and three wheels were situated below the whole to enable it to run on the ground. On either side of the car was an extended surface made of wood framework covered with silk, resembling the outstretched wings of a bird, and firmly stayed with wire, so that the two extended surfaces formed a trussed beam of great strength and lightness. A horizontal sail, which could be raised or lowered, was fitted to the stern, for the purpose of guiding the machine up or down, in addition to a vertical rudder for steering to right or left. To drive the machine, two propellers were to be employed, the engine and boiler being placed in the bows. The machine was

started by running down an incline, the propellers being simultaneously put in motion, so as to cause it to leave the ground at the terminus of the incline.

The whole apparatus weighed about 3,000lbs., and the amount of canvas or oiled silk necessary to support the machine was calculated to be equal to one square foot for each half-pound weight. This would make the area of surface spread out 4,500 square feet in the two wings and 1,505 in the sail, and a total of 6,000 square feet. The engine was designed to be of about 30 horse-power. A prominent feature of Henson's invention was the very great expanse of its sustaining planes, larger in proportion than those of many birds, and a steam machine-power of extreme lightness and efficiency. The machine was to start from the top of an inclined plane, in descending which it was to obtain the requisite momentum for its aerial journey. But, alas! when this wonderful device came to be tried, it was found to share the fate of all previous machines.

Henson became associated with another inventor, Stringfellow, and the two pursued various experiments. After many trials steam was the motive power adopted for a machine measuring 20 feet from tip to tip, giving 80 square feet of total sustaining surface, the weight being about 25lbs. On trial the machine proved too light; it ran well upon the wire, but failed to support itself when liberated. Stringfellow's own smaller model demonstrated the practicability of making a steam-engine fly, but otherwise the attempt was unprofitable.

Those, therefore, who were sanguine in the belief that Henson's machine was destined to realize the dream of Aerial Navigation were doomed to disappointment. The proceedings which were in progress to build one after his model, with which to cross the Atlantic, were suddenly countermanded, and efforts were made in a new direction for solving the problem. Some of the inventions, as M. Delcourt points out, will not stand the slightest investigation; others are repeated with so many modifications that it is difficult to form an opinion of their merits. Patents were, and are, frequently taken out for practically the same invention, inventors having neglected to ascertain what had already been done in that domain of science.*

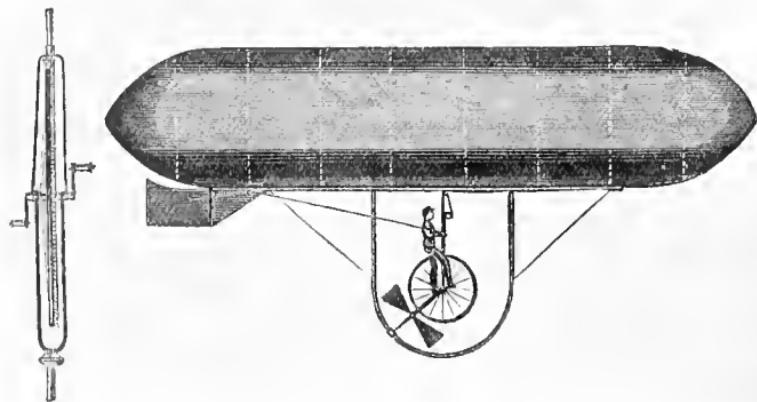
It was in 1846 that there was founded in Brussels the first aeronautical society. Its inception was mainly due to a desire to exploit the new dirigible system of Dr. van Hecke. In the course of that year the French aeronaut, Depuis Delcourt, secretary of the new society, made an ascent with the inventor, who desired to attest the superiority of his system of wings to supersede the use of ballast in causing the rise of the balloon. But the progress realized was insufficient to warrant a commercial exploitation, and the society was shortly afterwards disbanded.

Nevertheless, the attempt of Dr. van Hecke caused a new interest to be taken by inventors in the problem.

* A most excellent manual, which should be carefully studied by all such inventors, is Messrs. Brewer and Alexander's "Aeronautics," giving a complete list of aeronautical devices at the Patent Office during the last century.

In America Jenet devised a dirigible balloon, while Scott and Martainville proposed the elongated form of aerostat, now so familiar.

But the principal zeal and activity was displayed by a hatter named Pétin, whose scheme well deserves to be noticed at length. Seized with an unusual enthusiasm for aeronautics, Pétin constructed his models and then travelled throughout France organising subscriptions



GUSTAFSON'S NAVIGABLE BALLOON.

and demonstrating to all and sundry the excellence of his system of a dirigible air-ship, which he believed was to revolutionise the world.

Briefly, the Pétin apparatus when it was built consisted of four spherical balloons sustaining a platform of 70 yards or so in length, and 10 in width. It possessed some 1,200 yards of surface, and an ascensional force of 15,000 kilogrammes. The chief novelty devised was the addition of a frame-work sus-

taining two globes, serving to moderate the rise and descent, and of mobile frames around a horizontal axis by means of which one could, while the machine rose or fell, make progress in an oblique direction. But what did all this serve, when the inventor neglected to provide any effective motor for his invention? That which he provided was wholly inadequate. The much-vaunted screw principle had been tried many times in this connection, but never with the least success. Besides, it seemed as if their frail dimensions were altogether out of proportion to the enormous volume of the machine, and it was doubtful whether the wheels of these atmospheric turbines could work alone with the aid of the air's resistance. Pétin proposed to work them by hand "or by some other mechanical means." But it was precisely the difficulty then, and indeed is now—what mechanical means? Motors in 1850 were not available and a steam engine was too heavy.

It is interesting to know that the celebrated romancer, Théophile Gautier, was one of Pétin's warmest partisans, and in the course of a glowing description which he made at the time of his friend's invention occurs the following:

"The grand dimensions of this machine, approximating those of the nave of Notre Dame, or of a man-of-war, should not astonish. These gigantic proportions are a guarantee of security. . . . If one may be permitted to affirm anything in the present state of the project, one advances nothing that is not perfectly

logical and reasonable in saying that, from to-day the problem of aerial locomotion is *solved*, or else all the known physical laws are false and statics do not exist."

This marvellous air-ship was set up in the Champs Elysées, but the citizens of Paris were given no opportunity to test its value, the prefect of police refusing his authorisation to inflate the four balloons. The indignant M. Pétin came to England, and from hence to America, where he executed many ascents with an aeronaut named Chevalier. Twice he fell into the water, the first time into the Atlantic, and again into Lake Pontchartrain ; and it may be that these narrow escapes from death by drowning disgusted the ex-hatter with the whole business of aerostation. He returned to France and was glad to accept a modest post in a well-known commercial establishment in Paris.

About the same period, the Sansons, father and son, designed another dirigible balloon, in the form of a gigantic fish, made of varnished cloth, attached to a balloon of the Meusnier pattern. It was fitted with propellers worked behind the car by means of wings. The forepart of this machine was protected by a sheet-iron covering ; and the rear was garnished with a vast surface of triangular-shaped cloth disposed vertically, with a view to its action as a rudder. The propellers were wheels with large curved blades. The entire scheme, however, was never submitted to a public trial, but it is probable that, if it had been tried, the results

would not have been very satisfactory, owing to the absence of any serious motive power.

Human motive force cannot usefully be employed in aerial navigation, save in the working of simple wings ; its power is much too feeble, although this simple truth has not obtained, even to-day, universal recognition.

CHAPTER V.

NOTWITHSTANDING all the failures which had attended the efforts of the various experimenters in the first half of the last century towards the propulsion of balloons, such were the attractions of the subject and so great was the reward it offered, that professional enthusiasm was but little damped.

Perceiving a resemblance between aerial and marine navigation, the great revolution wrought in the latter by the substitution of steam for sails caused many of these inventors to turn to the steam engine as capable of employment in propelling their air-ships. At that time the objections to such employment were manifold ; the necessity of either relinquishing the use of the propeller after a very short period, or of descending to obtain supplies of fuel and water, seemed to render its application of but little value. To work a steam engine required not only an engine and boiler but a heavy weight of water and fuel. In 1850 the lightest form of marine steam engine weighed about 1,300 weight per horse-power, and when to this was added the weight of fuel and water and that of the men necessary to attend to the machinery, a sum total was

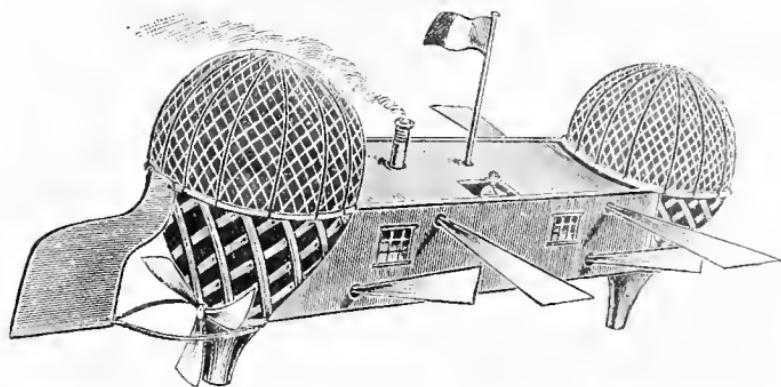
reached which, to most persons, appeared entirely beyond the power of any balloon to support. Yet amateur aerial navigators were then, as now, a difficult class to convince; their zeal was not readily quenched; and in a large proportion of the dirigible balloons of the period the motive power was to be furnished by steam, and this, strange to say, often without any alteration in the spherical shape of the balloon.

A fatal ascent, which caused a sensation in 1850, was that of Mr. Harris, who had accompanied Graham on a previous voyage. On this occasion a young lady, Miss Stocks, was with Harris in the car, when it rose from City Road, London. The balloon took a south-westerly direction, and pursued its course steadily for seven or eight minutes, when it entered a thick cloud and was lost to view. When about two miles high over Surrey, Harris prepared to descend, and pulled the valve line, but, from some cause or other, too much gas evaporated. As a consequence, the balloon descended about a mile perpendicularly with great swiftness, and the car fell in the park adjoining the mansion of Lady Gee. The gamekeeper and others ran to the car, only to find Harris a corpse and Miss Stocks insensible and apparently on the point of death. They were carried instantly to the Plough Inn, Beddington, where, after much surgical effort, the young lady recovered her senses, and eventually was able to return to her home.

In 1852 occurred another balloon accident, in which

the aeronaut, James Goulston, known to the public as Signor Lunardini, lost his life. It appears that he attempted a descent in a heavy gale, the balloon received a sudden check in its flight from the grapnels, the car was overturned, and its occupants dragged head downwards for a considerable distance.

The tragedy of Letur also belongs to 1852. This inventor believed that with his machine, a sort of



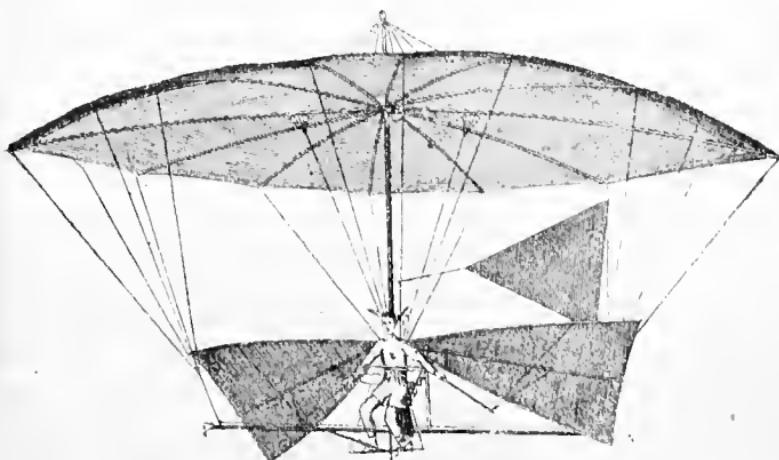
BOULT'S AIR-SHIP.

dirigible parachute, he could successfully embark in an aerial voyage from a balloon. Unfortunately, at the moment of his departure from the balloon, a high wind reigned ; the aeronaut did not hear the inventor crying to him to let go the rope, 80 yards in length, to the extremity of which Letur was suspended ; consequently the parachute and its inventor were thrown with violence against a clump of trees, and the latter was killed. This unhappy catastrophe was not, of course,

due to any defect of Letur's apparatus, but wholly to inevitable circumstances.

Among the most enthusiastic and enlightened aeronauts of the middle of the century was Henry Coxwell, who, in 1845, started *The Balloon, or Aerostatic Magazine*, for the exchange of ideas on the subject, and for fourteen years it continued to appear, much to the benefit of those who were pursuing the study of aerostation. Soon after starting this periodical Coxwell went on the Continent and made numerous ascents from Vienna, Brussels, Antwerp and elsewhere. At Berlin he showed the use of shells for destructive purposes in connection with ballooning. Forty feet below the car was slung a wicker battery, to which he descended by a rope ladder. From this coign of vantage he discharged grenades or petards and then reascended to his companions in the car, much to the gratification of the German military experts, who perceived that they had at hand a new engine of warfare. On one occasion, while crossing the Holstein frontier, he was taken for a Danish spy and shot at by the German sentries. One of Coxwell's memorable aerial flights was from Berlin towards Dantzig, a distance of 170 miles in three hours. About the same time (1849) a notable voyage was effected by M. Arban, who crossed the Alps from Marseilles to Turin, a distance of 400 miles in eight hours. Some years later Coxwell, on his return to England, made a voyage of 250 miles in five hours. He started one night at half-past 11 o'clock (June 15th, 1857) from the Pavilion

Garden, North Woolwich, and descended some three miles beyond Tavistock, Devonshire, just on the borders of Cornwall. So swift was the journey that it took some time before accounts of it gained credence; at Sidmouth the alarm was rung by the night watchman, but before the inhabitants were astir the balloon was out of sight, and the men laughed



LETUR AND HIS APPARATUS.

at it until the Devonshire papers were published giving an account of the voyage. At Newton Abbot the balloon was believed to be a fearful comet; a panic was imminent, which was stopped by the railway guard, who announced that the aerial visitor was Mr. Coxwell's balloon. The aeronauts walked to Tavistock and put up at the Queen's Hotel, where they had some difficulty in persuading

the worthy host thereof that they were in London five hours before.

Long before the day of "aeroplanes," the idea of the structure of a bird had appealed to most of the early flying-machine inventors. It was the guiding principle adopted by Lord Aldborough in 1854. This nobleman devoted many years—fruitless years—to an elucidation of his theory and registered several patents in this country, none of which, however, led to any practical result. Various theories on the flight of birds were propounded by this inventor, with the object, so he tells us, of imitating these actions with his artificial wings. He even arranged that the tail, which was to serve as a rudder, should strike downwards when the vessel rose, and so compress the air beneath, "as he believed birds commonly do, especially pigeons." So sanguine was this noble projector that he even went the length of drawing up plans for a landing place, having a railway for receiving air-ships, while a commodious building was provided for their reception. On the whole, Mr. Brewer is not unjust in describing Lord Aldborough's various inventions as "most vague and theoretical in their character."

Another peer of the same period taking a practical interest in aerostation was Lord Carlingford, who in 1856 patented a flying-machine. In this invention two wings of slightly concave form are fixed to the sides. The sustaining laths of these wings pass through the body of the car from one to the other, thereby holding them firmly in position. The wings serve the purpose

of an "aeroplane" resting on the air, but having no movement imparted to them. A tail and rudder are provided and the machine is propelled by means of the "Carlingford screw," worked by a hand wheel, situated in the bow of the car. His lordship proposed a sustaining power of 25 to 30 square feet, but even though the machines were to be increased in size the surface need not be proportionately increased. This conclusion was reached for the reason that "an eagle weighing 80 lbs. has only four times the floating surface of a rook weighing one pound." The machine was to be started by suspending the stern end of the car by means of a trigger and cord to the top of a 9 feet pole. The bow of the car is connected to two lines passing over pulleys on the tops of two other poles and a weight is attached to the other ends of these lines. By releasing the trigger, the lines at the bow are pulled forward by the descending weight and a machine thus receives a great forward propulsion. Once the machine was free, the speed might easily be sustained, the inventor thought, by turning the aerial screw.

"I have proved," he observes, "by experiment that an aerial screw of only five inches long can give a pull greater than a ten-pound weight suspended to a cord and drawing through a pulley; and as it will only take such a small force to maintain the flight of the aerial chariot, that what we look upon as fabulous may hereafter come to pass, and that, like the chariot of Jupiter, we may yet behold two eagles trained to draw the aerial chariot."

The great question in the minds of the new school of aviators was, what is the amount of supporting surfaces possessed by birds in proportion to their weight. To this Mr. de Lucy replied in terms that greatly encouraged the new school. He demonstrated in his treatise that the wing areas of flying animals diminish as the weight increases from about 49 square feet to the pound in the gnat to 0·44 square feet to the pound in the Australian crane. From these tables he inferred the broad law that the greater the weight and size of the volant animal, the less relative wing surface was required. But, of course, this statement demanded qualification, but even when corrected it overturned much former misconception.

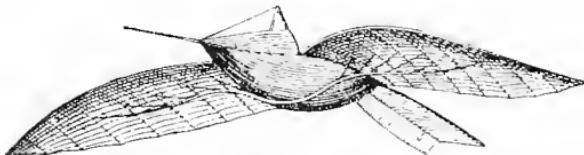
Among the most interesting passages in the story of modern aviation, is that narrating the singular career and experiences of the redoubtable Captain Le Bris.

This worthy was a French mariner who had in his youth made several voyages around the Cape of Good Hope and Cape Horn. His imagination had been fired by the sight of the albatross careering in the tempest on rigid wings and keeping up with the fleetest ships apparently without exertion. He had slain one of these and claimed to have remarked an extraordinary phenomenon. In his own words, as quoted by M. de la Landelle :

“ I took the wing of the albatross and exposed it to the breeze, and lo ! in spite of me it drew forward into the wind ; notwithstanding my resistance it tended to

rise. Thus I had discovered the secret of the bird. I comprehended the whole mystery of flight."

Possessed of an ardent imagination, Le Bris was early smitten with the idea of building an artificial bird capable of bearing himself, whose wings should be controlled by means of levers and a system of rigging. When, therefore, he had returned to France and had become captain of a coasting vessel sailing from his native coast of Finisterre, he designed and built with his own hands just such a bird of which an outline is



LE BRIS'S APPARATUS.

here presented. It consisted of a body in the shape of a sabot, or wooden shoe, the front portion being decked over, provided with two flexible wings and a tail. The body was canoe-built, $13\frac{1}{2}$ feet long and 4 feet wide at its broadest point, of light ash ribs, well stayed and covered on the outside with impermeable cloth so that it could float. A small inclined mast in front supported the pulleys and cords intended to work the wings. The latter were each 23 feet long, thus making the whole apparatus 50 feet across with about 215 square feet of supporting surface. The total weight of this artificial albatross was 92 lbs. The tail was hinged so as to steer both up and down and sideways. The front edge of the wings was made of a flexible

piece of wood, fashioned like the front edge of the albatross's wing; to this cross wands were fastened and covered with Canton flannel, the flocculent side downwards. An ingenious device, which Le Bris called his rotules (knee pans), worked by two powerful levers, imparted a rotary motion to the front edge of the wings and also permitted of their adjustment to various currents of wind. Le Bris was to stand upright in the car, his hands on the levers and cords and his feet on a pedal to work the tail. His expectation was that, given a strong wind, he would rise in the air and reproduce all the evolutions of the soaring albatross, without having recourse to flapping at all.

The first experiment of Le Bris was conducted on a public road at Trefeuntec, near Douarnenez.

Holding Comte D'Esterno's theory that it was necessary for such an apparatus to have an initial velocity of its own in addition to that of the wind, he chose a Sunday morning, when there was a good 10-knot breeze from the right direction. Disposing his artificial albatross horizontally on a cart, he started down the road against a brisk wind, the cart being driven by a peasant. The bird with extended wings, 50 feet across, was held down by a rope passing under the rails of the cart and terminating in a slip knot fastened to Le Bris's wrist, so that with one jerk he could loosen the attachment and allow the rope to run. He stood upright in the car or canoe, unencumbered in his movements, his hands being on the levers and depressing the front edge of the wings, so that the

wind should press upon the top only and hold them down. Assistants, moreover, walking along on either side, temporarily kept them in position. At the signal to these to let go, the driver was told to put his horse to a trot. It was at this moment that the inventor, pressing on his levers, slowly elevated the front edge of his wings ; they fluttered a moment, and then took the wind like a sail on the under side. After a little delay, the machine rose into the air and Le Bris found himself perfectly balanced, going up steadily to a height of nearly 300 feet, and sailing about twice that distance over the road.

But fearful cries rent the air ; an accident had taken place. At the last moment the running rope had whipped and wound around the body of the driver, had lifted him suddenly from his seat ; he clung to it involuntarily and it carried him into the air. He thus performed the chief function of the tail of a kite ; his weight by an extraordinary chance just properly balancing the apparatus at the assumed angle of incidence, and with the strength of the brisk wind then blowing.

Meanwhile, up above, the human albatross was winging his flight, feeling himself well poised in the breeze ; and exulting in the thought of a couple of hours in the air, unconscious that his late driver was hanging on to the rope and howling with fright and anguish.

As soon as Le Bris became aware of this unforeseen catastrophe he took instant measures for descent.

He altered the angle of incidence of his wings, came down slowly and manœuvred so ably that the driver touched earth unharmed, running off to recover his steed, who had abruptly ceased his gallop, probably when he caught a glimpse of his master careering in the sky. The equilibrium of the artificial albatross was now changed and Le Bris could not again ascend. He was lucky to manage with his levers to retard his descent, coming down quite unhurt himself, although one wing struck the ground in advance of its fellow and was somewhat damaged.

This achievement, as may be imagined, created a great noise in the district ; Le Bris was regarded as a hero and a lunatic by the different sets of local opinion, according to their prejudices. Being a poor man and without influence, it was some time before he was prepared to mend his machine and renew his experiments.

On the next occasion, while in mid-air over a quarry, his machine encountered a kind of vertical eddy ; it pitched forward, and fell towards the bottom of the quarry. As soon as the apparatus became sheltered from the wind it righted up, but could scarcely act as a parachute, and touching the bottom was smashed to pieces, Le Bris, who at the last moment suspended himself to the mast of the canoe and sprang upward, nevertheless had a leg broken by the rebound of the levers.

This catastrophe practically ruined Le Bris and put an end for a dozen years and more to any further attempt

to assert the soundness of his albatross theory. But in 1867 a public subscription at Brest enabled him to build a second artificial albatross. The inventor could, however, no longer boast the splendid audacity of youth. His experiments at least showed promise (on one occasion the bird rose 50 yards and flew four times that distance) when one day, leaving his apparatus for a moment unleashed, a rising wind caught it up and then precipitated it to the earth with a crash. This was the end. Le Bris' second machine was smashed to fragments, his means and credit were exhausted, and, perhaps, his courage. He retired to his native village, served with honour in the war of 1870, and two years later, while filling his appointment of special constable, was slain by some ruffians whose enmity he had aroused.

The longest voyage on record in a balloon was made by John Wise from St. Louis to Henderson, in New York State, a distance of 850 miles, in July, 1859. It was made in 19 hours, or at the rate of 46 miles an hour. It should be said, however, that the conditions which attended this voyage were extraordinary, the wind blowing a terrific gale. The enthusiastic aeronaut, after 500 ascents, eventually lost his life in Lake Michigan, owing to the rottenness of the fabric of his balloon.

A very singular machine was, in 1860, patented by J. K. Smythies. It attempted to utilise the aeroplanes as steam condensers and to shift the centre of gravity, while in flight, by means of water. The boiler was

to be upright, its top view indicated by the circles at the junction of the two planes. It was to be fitted with small vertical water-tubes, thickly placed in a "flame-chamber," heated by the combustion of some volatile fluid mixed with air. Back of the boiler an upright cylinder was to be placed to work the wings up and down, feathering motion being imparted to the vanes composing them (by compound levers), so that they should separate slightly on the up-stroke and firmly close on the overlap on the down-stroke.

The whole of the two aeroplanes and of the upright boilers, was to be encased in a closed flat bag of oiled silk or other light airtight covering, which was to be kept distended by spars and by light cords.

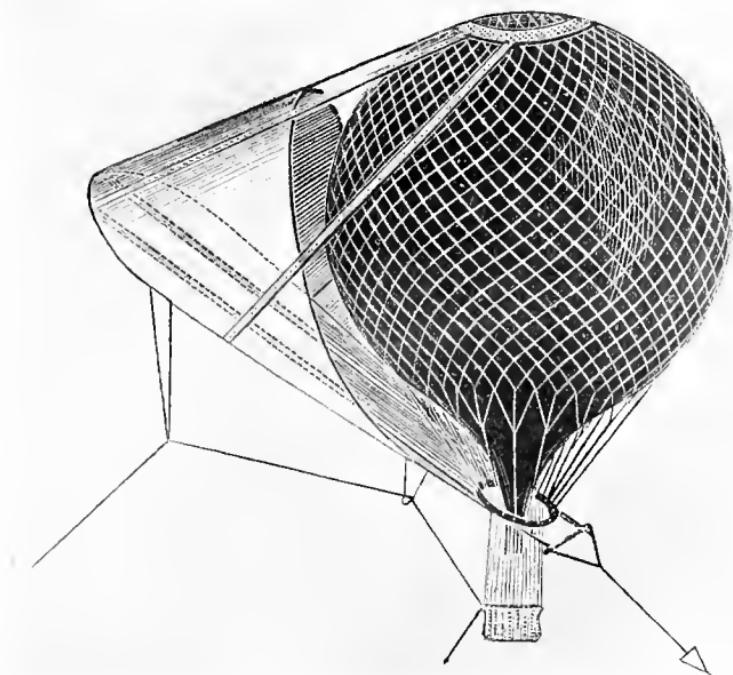
The spent steam was to be exhausted in this hood or covering, so as to be condensed by contact with the sides, and the water thus produced was to drain into a reservoir at the bottom, whence it was to be pumped back into the boiler, thus keeping the total weight of the apparatus constant, and utilising the same water over and over again.

As for the operator in this wonderful flying machine, he was to be suspended in an adjustable seat beneath the centre of gravity, when, by shifting his position sideways, or fore and aft, he was to guide the machine in its aerial journey. Elastic legs beneath were provided to break the fall on alighting, the descent being also retarded by the action of the wings.

Of course, the apparatus proved quite as unpracticable as its forerunners, but, nevertheless, the inventor

showed that he had studied closely the action of birds, and was aware, at least, of the necessity for adjusting during flight the centre of gravity to coincide with the centre of pressure, a necessity which had not occurred to his predecessors.

Years later, in 1882, this same inventor designed



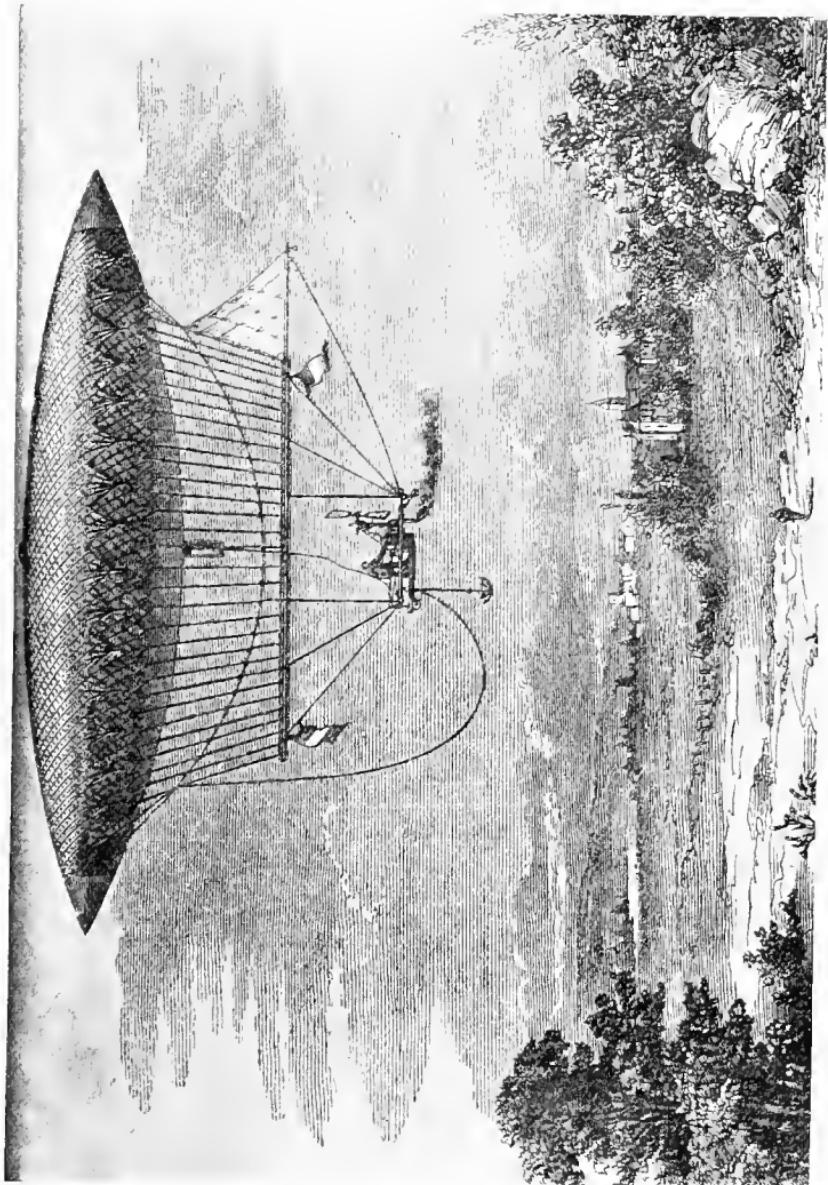
ARCHIBALD'S KITE BALLOON.

a flying machine which actually did fly, but it was only a small model. Two wings were fulcrumed to the sides of a light steam carriage, and were flapped up and down by the action of the cylinder. The machine was worked by a multitubular boiler, using benzoline vapour.

Once the screw principle had been invented and applied with such success to steam-boats, no great time elapsed before it was utilised by aeronautic inventors, at first in their models and specifications, and, afterwards, in actual practice.

In the device of the Viscount de Ponton d'Ame-court (1861), two propellers were mounted on a vertical axis, one above the other, and situated at the upper part of the machine. These propellers were made to revolve in opposite directions, thus exerting an upward force, whilst at the same time one propeller keeps the other in proper equilibrium and prevents the apparatus taking a gyratory motion. In this, as in other details, the viscount was merely borrowing — perhaps unconsciously — from Henry Bright, whose flying machine was patented in 1859.

The first attempt to make a dirigible balloon on principles really scientific, and recognised to-day, was, in 1852, by a young French engineer, M. Henri Giffard. He had evidently carefully studied the subject, and had thus arrived at a thoroughly practical appreciation of the necessary conditions. Abandoning the globular shape, as offering too much resistance, and following the analogy of a marine vessel he constructed an oblong pointed balloon, to the stern of which he attached a rudder. In the car he carried a small steam engine which worked a screw, formed of sails like a windmill. The accompanying illustration will give an idea of Giffard's balloon. It was about 150 feet long, and 40 feet diameter. It con-



GIFFARD'S STEAM AIR-SHIP.

tained 88,000 cubic feet, and was filled with coal gas. The engine was three-horse power, weighing 3 cwt., and turning the screw 110 revolutions per minute. It seemed rather a daring thing to put the furnace of a steam engine so near to a huge reservoir of highly inflammable gas; but Giffard adopted, among other precautions, the ingenious device of turning the chimney downwards, producing the draught by the steam blast, as in a locomotive engine. He thus considered himself free from any danger of fire.

The ascent was eagerly awaited by the whole scientific and artistic world. It took place from the Hippodrome in Paris, on September 24th. The wind was strong, and Giffard did not expect to hold against it; notwithstanding which, he found he could make a headway through the air of five to seven miles an hour, which enabled him to execute various manœuvres of circular motion with perfect success. The action of the rudder proved to be very sensitive. No sooner, he tells us, did he pull gently one of the cords, than he saw the horizon turn round him like the moving picture in a panorama. He rose to a height of nearly 6,000 feet, but, as night approached, he extinguished his fire and landed safely in a field near Elancourt.

On account of this voyage, Giffard has been called the Fulton of aerial navigation. His experiment with steam power was certainly a great stride forward in the science of aeronautics. But many were too sanguine concerning his achievement, as witness Emile

de Girardin in writing at the time: "Maritime steam navigation has changed all the relative conditions of existence, insular and European, for Great Britain. Is there for France a solution more important than that of the problem of aerial navigation? Aerial navigation by means of steam rises to the height of an immense political question."

In 1855, Giffard built another balloon of larger dimensions, which confirmed the results already attained. Yet, on the other hand, he found that before the direction could be completely controlled, many improvements would be necessary, which would involve much time and trouble. His attention was just then occupied with other mechanical inventions (amongst them the famous locomotive injector, now in universal use), but he did not altogether abandon the subject, for, in the great captive balloon, constructed by him in 1867 and 1868, Giffard perfected several of the desired improvements, such as the impermeability of the envelope, a more mechanical construction of the valves, and a better and cheaper mode of preparing pure hydrogen.

One of the earliest combatants of the principle that a balloon could ever be made dirigible was Nadar, a renowned Parisian photographer, who spared neither energy nor eloquence in proclaiming his special theories. Chief amongst these was, that in order to move oneself in the air it was necessary to suppress balloons; that to contend against the air, it was requisite to be heavier—not lighter—than the air. The idea of steer-

ing balloons he roundly declared to be an absurdity, and that the solution of the problem was to be found in an aeromotive propelled by a screw.* Not having at his disposal sufficient funds to construct such an aeromotive, he at length hit upon the ingenious plan of constructing what he announced would be the "last balloon"—to procure the necessary resources, not by public subscription, but by a spectacle interesting enough to secure the desired results. In short, he set about building a leviathan balloon—or rather two balloons, one within the other—which would bear the terrific pressure of 6,098 metres of gas, would be nearly 200 feet high, employ 22,000 yards of silk, and support $4\frac{1}{2}$ tons. It would, according to M. Nadar, be twenty times larger than the largest, and "afford the most beautiful spectacle which it has been given to man to contemplate." The idea of a "compensator"—of a second or auxiliary balloon—originated with Louis Godard; it was designed to receive and preserve the excess of gas produced by dilation, instead of losing this excess, which had hitherto been the case, and so permit of far longer voyages.

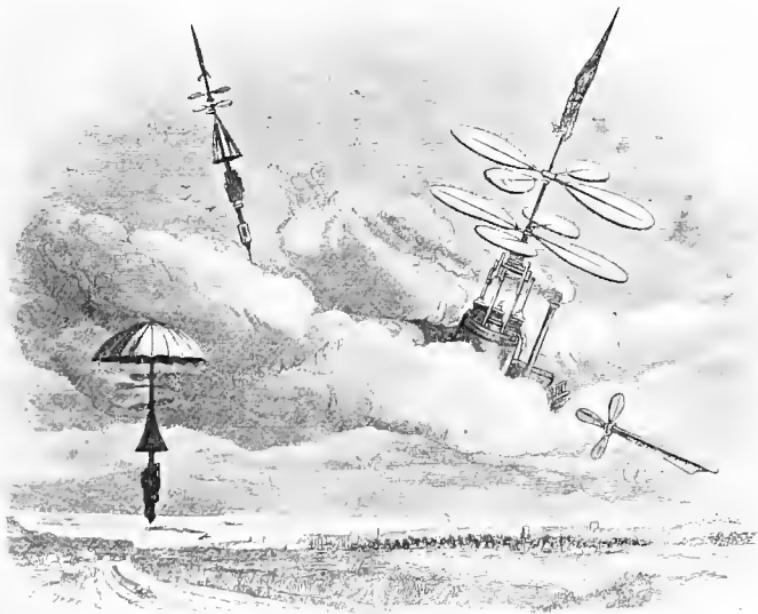
Nadar's idea was put into execution during the summer of 1863. The feature which from the first attracted the chief public interest, prior to the ascent,

*This idea of the heavier-than-the-air principle was well stated by the Duke of Argyll in London about this time. "We all know," said he, "that a bird is never buoyant. A bird is immensely heavier than the air. We all know that the moment a bird is shot it falls to the earth; and it must necessarily do so, because one of the essential mechanical principles of flight is weight, without which there can be no momentum and no mature force capable of moving through atmospheric currents."

was the car, which rather resembled a small house or cabin, the familiar subjacent appurtenance of a balloon. It was of wickerwork, of square construction, on the roof of which the passenger was to stand, as on the deck of a vessel. Below was a first and second floor, with saloon, a compartment for scientific instruments, three sleeping cabins, besides provisions and luggage compartments. On the exterior of the house were grapnels, wheels and fowling pieces, besides two speaking trumpets and further provisions. In fact, as one journal observed, one might suppose that the travellers expected to descend in some wild distant land where no food could be obtained. The wheels mentioned were intended to be put to the car after alighting, in order to convey it back with horses. Nothing was forgotten — scientific instruments, a printing press, photographic cameras, games, two cages of carrier pigeons, six baskets of wine, and “a supply of confectionery enough for three boarding schools.”

This celebrated ascent of the “Giant” took place on the 4th October from the Champs de Mars, where eighty years before Montgolfier had first astonished the Parisians. The entire plain was closely packed with spectators, but, unhappily, the barriers appear to have been broken and only some 25,000 paid the required admission fee of 1 franc. The preliminary operations took some time, subjecting the patience of the spectators to a severe trial, but slowly the inflation was made, until the top of the monster of white silk was only fourteen yards lower than the tower of Notre

Dame. It was held down by about one hundred men and the weight of two hundred sandbags. Fifteen passengers took their places in the car, as follows:—M. Nadar, captain; MM. Marcel, Louis and Jules Godard, Lieutenants; the Prince de Sayn-Wittgenstein, Count de St. Martin, M. Tournachon (Nadar's



PROJECT OF M. NADAR (1863).

brother), MM. Eugere Delessert, Thirion, Piallat, Robert Mitchell, Gabriel Morris, Paul de St. Victor, De Villemessant, and one lady, the Princess de la Tour d'Auvergne. It appears that the Princess was taking her usual drive to the Bois de Boulogne, when noticing the commotion in the neighbourhood of the Invalides, she enquired the cause, and ordered her coachman to

drive to the Champ de Mars. Having seen the balloon she expressed a desire to make the ascent, and although Nadar had to the last moment refused to take any lady, even his own wife, he was unable to resist the entreaty of the Princess. When all was ready, Nadar mounted into the network and took off his hat to the spectators. The word of command was given, “*Lachez Tout!*” and the gigantic aerostat rose majestically into the air.*

The following list of rules had previously been drawn up, and were now displayed in the saloon :—

“ 1. Every traveller on board the ‘*Geant*’ must take, before mounting, knowledge of the present rules, and engages himself upon his honour to respect them and to make them respected, both in the letter and in the spirit. He accepts and will obey this obligation until the descent.

“ 2. From the departure until the return there shall be only one command, that of the captain. That command shall be absolute.

“ 3. As began, penalty cannot be enforced, the captain having the responsibility of the lives of the passengers decides alone, and without appeal, in all circumstances the means of assuring the execution of his orders with the aid of all under him. The captain can, in certain cases, take the advice of the crew, but his own authority is decisive.

*As this is a history of Aerial Navigation it cannot fail to interest those who now confidently look forward to the achievement of a practical system for the conveyance of passengers and freights through the air, to read this list of “*Rules*” drawn up by M. Nadar.

“ 4. Every passenger declares, at the time of ascending, that he carries with him no inflammable materials.

“ 5. Every passenger accepts, by his simple presence on board, his entire part and perfect co-operation in all manœuvres, and submits himself to all the necessities of the service ; above all, to the command of the captain. On landing he must not quit the balloon without permission duly acquired.

“ 6. Silence must be absolutely observed when ordered by the captain.

“ 7. Victuals and liquors carried up by the travellers must be deposited in the common canteen, of which the captain alone has the key, and who regulates the distribution thereof. Passengers have no claim to victuals and liquors except when on board.

“ 8. The duration of the journey is not limited ; the captain alone decides the limitation : the same judgment decides, without appeal, the putting down of one or more travellers in the course of the voyage.

“ 9. All gambling is expressly prohibited.

“ 10. It is absolutely forbidden to any traveller to throw overboard ballast or any packet whatever.

“ 11. No passenger can carry up with him luggage exceeding 30 lbs. in weight, and occupying more space than an ordinary travelling-bag.

“ 12. Except in very rare cases, of which the captain alone shall be judge, it is absolutely forbidden to smoke on board, or on land within the vicinity of the balloon.”

When they had attained the height of 4,000 feet the passengers saw the sun, which had set for the earth below more than two hours before. The effect of this brilliant light upon the balloon is described as something marvellous, and threw the travellers into a sort of ecstasy. The balloon took a north-easterly direction ; but it was destined to effect a long journey, for to the surprise of the majority of the passengers a perilous descent was made at nine o'clock at Barcy, near Meaux. The car dragged on its side for nearly a mile, and the passengers took refuge in the ropes to which they clung. Several were considerably bruised, although none sustained any serious injury. Nadar, visibly uneasy about his fair charge the young Princess de la Tour d'Auvergne, was implored by her to attend to his duty as captain. "Every one at his post," said she, with forced gaiety, "I will keep to mine." It is said that the descent was decided upon in consequence of the advice of the brothers Godard, and against Nadar's plans, who, however, yielded in deference to the wisdom of these experienced aeronauts. It turned out that they supposed that the wind was blowing them out to sea and certain destruction, when, as a matter of fact, they were travelling due east, with the Caspian as the nearest sea in their path. When this unlucky descent was effected, the lights and the speaking trumpets soon attracted a number of peasants, who brought carts and helped the party to the village of Barcy, where most of them passed the night, although Nadar and the Prince de Wittgenstein, with two or

three others, booked the first train from Meaux to Paris, where he was the first to report upon the affair. He attributed the forced descent to the presence of electrical disturbance in the atmosphere which destroyed the equilibrium of the car, and also to the violence of the wind and the utter darkness.

Nothing daunted by the accident he and his monster balloon had just suffered, Nadar accomplished another ascent on the 18th of October, again from the Champs de Mars. On this occasion the Emperor and the young King of Greece were present, the former of whom had a long conversation with the aeronaut prior to starting. This time eight persons, including Madame Nadar, embarked in the "Geant" for unknown regions. At nine o'clock they were over Erquelines, and by midnight the balloon and its human freight were over Holland. From time to time it was necessary to descend somewhat to take their bearings. Nobody on board slept, so great was the excitement, conjoined to the fear of falling into the sea which was present to every mind.

"In the morning, after a frugal breakfast made in the clouds, we redescended. An immense plain was beneath us; the villagers appeared to us like children's toys, rivers seemed like little rivulets—it was magical. The sun shone splendidly over all. Towards eight o'clock we arrived near a great lake; there we found out our bearings, and announced that we were at the end of Holland, near the sea."

A violent gale arose, so that when the anchors were

thrown out they were instantly snapped short, and after a brief rise the balloon fell and began a fearful and giddy career. All disappeared before them—trees, thickets, walls, all broken or burst through by the shock. Sometimes it was a lake into which the car plunged, then a bog, the thick mud of which entered their mouths and eyes.

“It was maddening,” writes one of the passengers. “‘Stop! Stop!’ we shouted, enraged with the monster who was dragging us along. A railway was before us—a train passing. It stopped at our cries, but we carried away the telegraph posts and wire. An instant afterwards we perceived in the distance a red house—I see it now—the wind bore us straight for this house. It was death for all, for we should be dashed to pieces. No one spoke. Strange to say, those nine persons—one of whom was a lady—who were clinging to a slender screen of osier, for whom every second seemed counted, not one had any fear. All tongues were mute—all faces were calm. Nadar held his wife, covering her with his body. Poor woman—every shock seemed to break her to pieces.

“Jules Godard then tried and accomplished an act of sublime heroism. He clambered up into the netting, the shocks of which were so terrible that three times he fell on my head. At last he reached the cord of the valve, opened it, and the gas having a way of escape the monster ceased to rise, but it still shot along with prodigious rapidity.”

Suddenly, however, a forest appeared on the horizon;

the voyagers must leap out at whatever risk, for they felt that the car would be dashed to pieces at the first collision with the trees. One jumped and made numerous somersaults, falling upon his head. Another, St. Felix, was stretched on the soil, fearfully wounded, his arm broken, his chest torn, and an ankle dislocated. Nadar had a dislocated thigh ; his wife had fallen into the river. But after a time the travellers were picked up, vehicles were brought, and they were thus conveyed to Rethem, in Hanover.

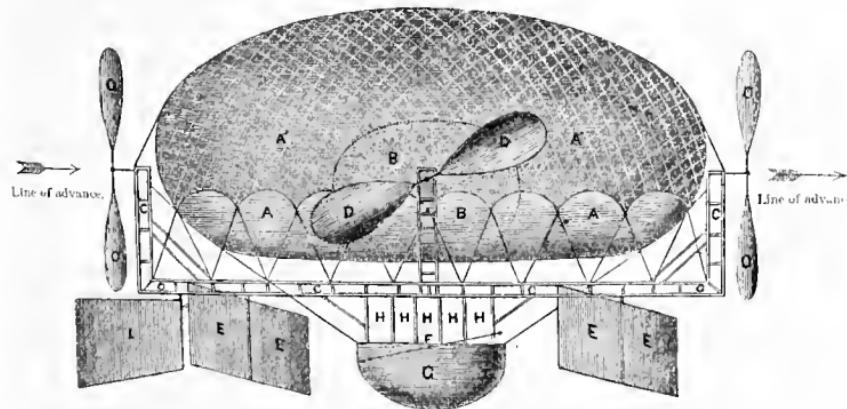
In seventeen hours they had made nearly 250 leagues. The "Geant" afterwards made other memorable voyages, but none which could compare in dramatic intensity to the one we have just described. It is only necessary to add that Nadar's balloon never fulfilled the purpose for which it was built, and its owner's projected screw air-ship continued to be "merely in the air."

But many of the first aeronauts of the day, especially those of the French nation, pinned their faith with M. Nadar to the screw or *helice* principle. The theory was by no means new, for as far back as 1768, fifteen years before the ascent of the first Montgolfier, Paucon, the engineer, predicted for the screw its employment in aerial navigation. Nevertheless, it is due to Nadar to say that he first invoked the sympathetic concurrence of all to popularise the idea and to facilitate its practical application. In this he was heartily supported by M. de P. Ponton d'Amecourt, inventor of the *aeronef*, and M. de Landelle, the latter of

whom constructed a series of ingenious working models.

Nearly everyone has seen the toy called the spiralger. It consists of four small flat fans, or rather spirals of paper, edged with wire, and attached at equal distances to a central spindle of light wood. This spindle is inserted into a hollow tube, with a rotary movement, upon an immoveable axle, which is held by the left hand. A string passed round the spindle, and quickly pulled by the right hand, impresses upon it a rotary movement sufficient to enable this miniature screw to detach itself and rise several yards high in the air, whence it descends as soon as the force imparted to it has exhausted itself. From this was deduced spirals of a material and an extent sufficient to support any motive power whatever—steam, ether, compressed air—and also that this motive power has the permanence of forces employed in ordinary industrial pursuits. By regulating at will, as a driver does a locomotive, it was believed one could rise, descend, or remain motionless in space, according to the number of revolutions made by the screw. The working models were publicly exhibited in Paris, and found to work well, although on a somewhat too small scale. Yet it was declared that the first step was gained, and the result, small as it was, was fundamental. According to M. Babinet, height alone gives direction; once the aeronaut has obtained elevation, a capital of strength was invented and employed upon which he could draw at will. It is a fact that Mlle. Garnerin once wagered

to guide herself with a parachute from the point of its fall to a place mutually selected, at a considerable distance. She won the wager, by so manipulating her parachute as to cause it to incline and manœuvre towards the designated spot, thereby copying closely the hovering descent of certain large birds. The Nadar screw, therefore, promised to furnish adequate



DAVID'S SAILING AEROSTAT (VERTICAL SECTION).

propulsion to a great height, and as often afterwards as required.

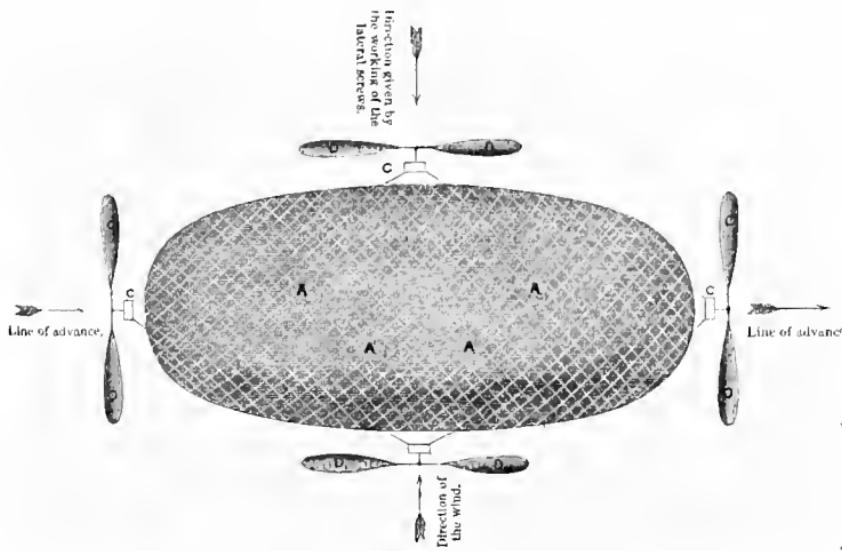
These ideas of Nadar and the French aeromotive party, so boldly expressed, drew forth the energies of a large number of scientists, and many articles and pamphlets appeared on the subject. Among the many projects of the day was that of M. David in 1864, who combatted the notion that a balloon aerostat of whatever shape was of no utility for the purpose of aerial navigation, and proposed to combine it with the screw

principle, and even with sails. His aerostat was of a long oval shape (resembling a sausage), and the manner in which he designed to work may readily be gathered from the illustrations (pp. 163 and 165).

The same Monday night in July, 1865, that saw Simmons and his balloon descending near Warwick, witnessed the catastrophe of Henry Coxwell and his cloud companions, and the escape of their balloon "Research" after its ascent from Belfast. With the exception of the leader of the expedition and one or two others, the voyagers seemed to have been overcome by a panic no sooner was control lost over the balloon. They became converted into mere cowardly and selfish savages, trampling upon one another in their frenzy to drop from the car as it dragged or bumped along the earth. All had thus dropped but one, a Mr. Runge, when the "Research" suddenly shot upwards, carrying that solitary passenger into the air, destined for a long horizontal flight. Compared to this flight, the voyage of the "Ancient Mariner" was but a pleasant excursion. When he descended within speaking and hearing distance of the Ulster mountaineers, men only gazed upon him in speechless horror or helpless bewilderment. It was only to the humanity of the women folk that he could trust for succour, and from that chance he was soon ruthlessly torn away. At last, after being battered almost to a mummy among the bare and ragged rocks of Carnlough, the balloon passed over a hawthorn hedge. Upon this hedge the traveller contrived to fall, and thus save his life at the

cost of further painful bruises. The "Research" meanwhile, whirled away seaward and was lost.

In 1863, a French engineer and mathematician, M. de Louvrié, proposed what he termed an "Aeroscaphe." It consisted of a kite-like surface, stiffened by light cords to a mast above and to the car below, and capable of acting as a parachute, as well as



DAVID'S SAILING AEROSTAT (HORIZONTAL SECTION).

of being folded like the wings of a bird. His proposal was the result of a mathematical investigation of the action of air upon aeroplanes and under the wings of birds. M. de Louvrié asserted that Navier and other mathematicians had grossly over-estimated the power required for flight. His writings were sharply attacked by other aviators, who had been promoting the imitation of flapping wings, while denying altogether

the possibility of a soaring or sailing flight of birds. Although De Louvrié, as well as Carlingford and Du Temple, asserted the possibility of such soaring upon the wind like a bird, each proposed some sort of artificial motor, and none was bold enough to trust to the wind alone as a motive power. This was reserved for Count d'Esterno, who published in 1864 a very remarkable pamphlet upon the evolution and flight of birds, in which he declared that the act of flight involved three distinct requirements, namely, equilibrium, guidance and impulsion, and that the latter could be obtained from the wind whenever it blew strongly enough.

“Sailing flight,” said, he “labours under the disadvantage that it cannot take place without wind, but on the other hand we can derive from the wind, when it blows, an unlimited power, and thus dispense with any artificial motor. In sailing (or soaring) flight a man can handle an apparatus to carry ten tons just as well as one only carrying his own weight. Whoever has seen large birds of prey sailing upon the wind knows that, without one flap of their wings, they direct themselves as they choose, save when they want to go dead with the wind or dead against it, on which occasions they must either back or sweep in circles.”

D'Esterno's invention was simple, but required so many delicate manœuvres to accomplish the various evolutions that no one tried it. The fact was admitted that a bird does all these things by instinct ; it is easy for him to alter the angle of incidence, the direction,

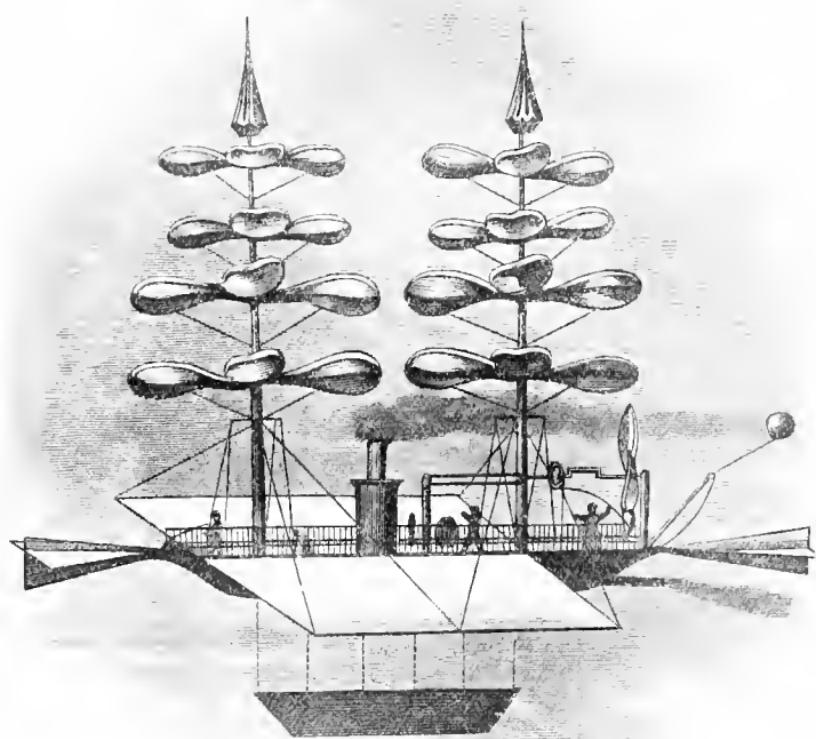
the speed, and to maintain the equilibrium at all times. He performs the exact manœuvre required accurately, at exactly the right time, and is always master of his apparatus. But a man would be at a terrible disadvantage ; his perceptions and his operations, without a life training would be too slow, and a single false movement might prove fatal.

At the same time it is worth noting that Count d'Esterno proposed that the experiments should be conducted over water sufficiently deep to break the fall ; the apparatus being raised like a kite by a cord fastened ashore, which the operator could hold fast or abandon at will while he was acquiring the science of the birds. Indeed, we venture the opinion that with such an apparatus it would prove highly profitable to a professional acrobat to devote some time to the acquisition of the flying art, with a view to turning it to public use. Strange to say, public prejudice against the doctrine of aviation was so strong at the time that d'Esterno's proposal was universally laughed at, and the Count did not persist in building his apparatus. The very existence of a soaring or sailing flight of birds was strenuously denied. It was held that there must be some small movement by the wings, which sustained the bird in the air, and which the observers had failed to detect. At a later day, when the observations of Penaud, Wenham, Baste, Peal, Darwin and Mouillard of soaring birds had proved the contrary, d'Esterno was urged to build his soaring apparatus. But he was then an old man ; he conferred with M.

Jobert, who arranged to build it, but it was only half-finished when d'Esterno died, at the age of 77.

In 1865 M. de Villeneuve began his extraordinary experiments towards solving the problem of the flight of birds. During the ensuing quarter of a century, this inventor designed and operated nearly 300 experimental birds, so that a portion of his house became a complete aviary of artificial birds. He also built a huge steam bird on the model of a bat. As there was at the time no sufficiently light and reliable steam-engine with boilers to furnish the requisite power, he arranged a short flight with only the engine on the bird, connecting it with the boiler on the ground by means of a hose. As soon as the steam was turned on the wings beat violently and the machine rose, with the inventor on board. Fearful that the bird would rise in excess of the length of the hose, de Villeneuve shut off steam so abruptly that the bird tumbled downwards, breaking one of its wings. The inventor declared he only wanted a very light motor to wing his flight heavenwards with his steam bird. It would weary the reader to mention all the similar flying projects of this period, even those of Jobert, Nadar, Ponton, d'Amecourt and Penaud alone.

In 1865 Europe was entertained by the publication of the project of M. de la Landelle. The designs showed a hull flanked with aeroplanes and surmounted with two masts, each carrying four sets of screws and also a partly-folded umbrella, which would open into a parachute. Letur's fate did not discourage other in-



LANDELLE'S AIR-SHIP.

ventors from constructing similar machines, whereby the motive power was wholly or in part to be that which resides normally in the human body. In 1865 Gustave Rothleb's device attracted some attention. Its principal feature was a windrose, with arms like the sail of a windmill, and a revolving wheel with feathered spokes to act as a rudder. The onward reaction was to be obtained by wings worked by the arms of the person flying, assisted by spiral springs. Two elastic reservoirs of hydrogen are attached to the frame to assist in buoying up the human being who should rashly undertake the flight.

One Richard Boyman, who, during the "sixties," devoted much time to the study of aeronautics, sought to convince the world that aerial navigation can never be accomplished by mechanical flight. He entered into a spirited controversy with the Duke of Argyll, Dr. Pettigrew and Dr. Arnott, who differed from him, maintaining that aerial machines must displace a quantity of air of equal weight to the entire aerial machine with its cargo. He therefore proposed to construct a machine having a steel aerostat and weighing in all 600 tons. The aerostat (one could hardly call such a structure a balloon) was to be cylindrical with conical ends, 200 feet in diameter and a quarter of a mile long! Yet the resistance would be only 5,070lbs., and the propelling force 406 horse-power. Yet propulsion was to be employed (*i.e.*, propulsion by the impact of a current of air coming from the machine itself), which might emanate either

from steam or be produced by a blower of the rotary type. The reaction-nozzles revolved so as to propel or back the vessel, and also to act as elevators and depressors. Rudders were provided for, working in pairs, one fore and one aft.

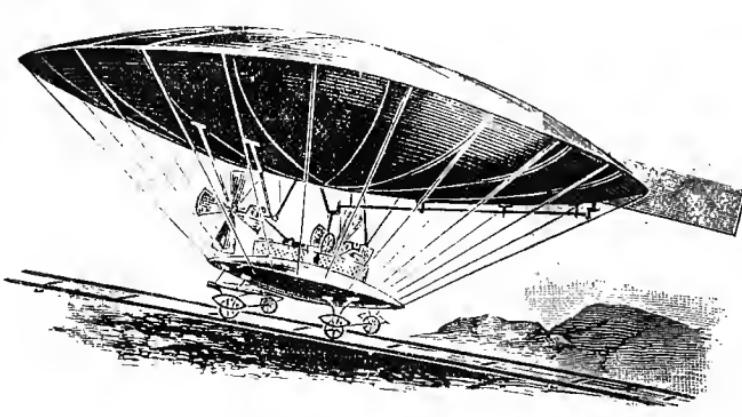
As to the gas for heating the boilers in Boyman's machine, the supply could either be obtained from the aerostat or it might be stored in separate receivers. Water was to be injected into the boiler by a steam injector, whilst moveable ballast kept the machine at the required angle. But, for all its ingenuity, nothing came of the invention.

It may have been the foregoing device which led a Frenchman, Marius Michel, to eschew artifice and go back to Nature. He sought to obtain a patent in this country for the employment of birds themselves, living and active. His idea was to harness them to a triangular framework, to which latter the car was suspended. The birds—he did not specify the variety, but he probably intended rocs—were to be guided by means of reins attached to their wings! Beside this device, (which, however, was not original), all the other schemes for flying-ships and aerial machines of the period appear very tame indeed.

Yet even so recently as 1890, a lady inventor, Miss Clara Wells, announced her resolve to employ birds to aid her balloon railway project. She proposed to train hawks and large birds for this purpose.

The navigable balloon invented by Paul Hanlein in 1865 was of elongated form, with a horizontal frame-

work around same. It was driven by a propeller and steered by a rudder covered with silk. Instead of propellers at the bow, propellers were situated on either side of the balloon, and mounted in the framework. A propeller is also mounted on a vertical axis situated below the car, for regulating the altitude of the balloon. The propellers were to be driven by a gas-engine of particular construction, having most of the working



BENGER'S NAVIGABLE BALLOON.

parts hollow to produce lightness, while the gas required is drawn direct from the balloon. To compensate for such loss of gas, a small auxiliary balloon, situated inside the principal aerostat, is inflated with air.

Jullien, a French clock repairer of Villejuif, who had in 1858 exhibited the first model of a fish-shaped balloon which operated with its own motor, propeller, and steering gear, sought to show what could be done with

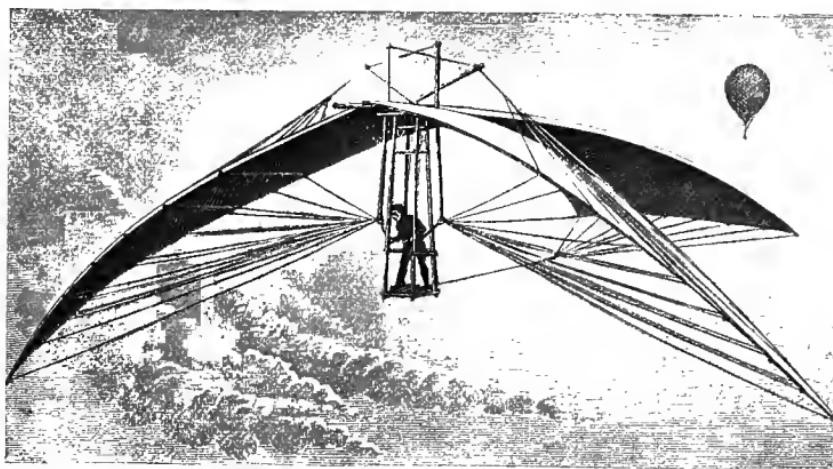
aeroplanes. He, therefore, constructed a model, which he exhibited before the French Society for the Encouragement of Aviation, and a few years later announced that he had succeeded in devising an electric motor and battery, weighing at the rate of 82lbs. per horse-power, with which he expected to drive an aeroplane through the air during an entire day. But this ingenious inventor failed, like many others, to receive encouragement, and finally died miserably poor in a hospital in 1877.

At the first exhibition of the Aeronautical Society of Great Britain at the Crystal Palace, in 1868, Mr. Charles Spencer exhibited a contrivance which attracted considerable attention. The machine consisted of a pair of wings, measuring each 15 square feet in area, to which was attached an aeroplane, measuring 110 feet more, and also a tail like a boy's dart and a longitudinal keelcloth to preserve the equilibrium, the whole weighing 24lbs., and giving a sustaining surface of 140 square feet. The inventor himself being an athlete, he was able at the trials to accomplish short horizontal flights of 120 to 130 feet by taking a preliminary run down a little hill. In these he was wholly sustained by the air. Spencer's apparatus differed from the flying machine of his predecessors in possessing an aeroplane of about the relative area to the wings of the larger.

In 1868, Mr. W. Gibson exhibited an apparatus consisting of two pairs of wings, actuated by the hands and feet together in such a manner as to impart a

movement similar to that of birds. He had previously succeeded in raising himself from the ground, but of the projected machine nothing more was heard.

Vaussin Chardanne was a prolific inventor who, between 1858 and 1873, published numerous schemes of aerial navigation. One of his projects was a "fish-gondola," in which the balloon was separated into two



DE GROOF AND HIS FLYING MACHINE.

parts, the propelling screws being in the middle and at the side.

In 1865 there came to Paris a young Belgian shoemaker named de Groof, who was firmly possessed of the idea that he had invented a machine which would safely navigate the atmosphere. But the aviators in the French capital received him coldly, and after many protracted delays he obtained support for his scheme on this side of the Channel, and made his experiment at Cremorne Gardens in June, 1874.

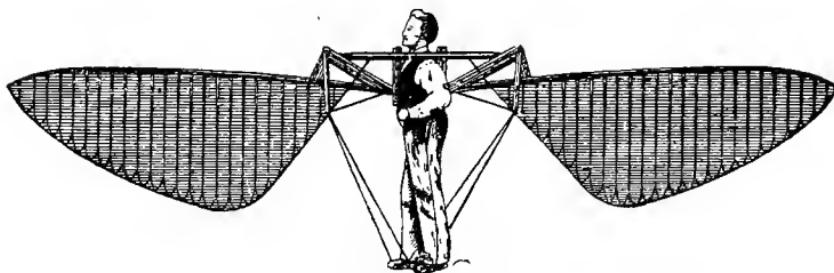
In the presence of a huge crowd de Groof rose with his machine attached to a balloon. At the height of 5,000 feet he gave the signal to the aeronaut, Simmons, who was obliged to allow a large escape of gas proportionate to the inventor's weight. On this occasion, however, both balloon and flying machine came down together, and it was not until the 9th of July that he actually severed the rope at a height of 3,000 feet in order to descend alone to earth.

In vain did the inventor strive to work his wings ; he and the machine fell swiftly and vertically, and in another moment struck the pavement of Robert Street, Chelsea, with a sickening thud. De Groof was a dead man before he had a chance properly to try his handiwork. Not only this, but the ascent was doubly unfortunate, Simmons the aeronaut having a narrow escape from death. For when de Groof detached his apparatus, the balloon, suddenly lightened, rose with such fearful rapidity that Simmons lost consciousness. When he regained it, he was in full descent. Just beneath him lay a railway ; as he fell on the line his eye caught a train running upon him at full steam. Another moment and he would have met a cruel death, but the quick reversal of the valves and the assistance of some spectators rescued him in the nick of time.

A machine, something similar to de Groof's, was that of Dandrieux's, in 1874, but its success was infinitesimal, and we must wait until the experiments

of Lilienthal before describing anything of importance in aviation.

We may well close this chapter by a reference to the achievements of the celebrated James Glaisher, which, however, belong more properly to meteorological science than to aerial navigation. Among Mr. Glaisher's



DANDRIEUX AND HIS MACHINE.

thirty ascents, the most remarkable are those of the 15th January and 5th September, 1862; the 31st March and the 18th April, 1863. In the first mentioned he surpassed the altitudes to which Gay-Lussac alone had ascended: and of his observations he has given us a full account, which will well repay consultation by the enquiring reader.*

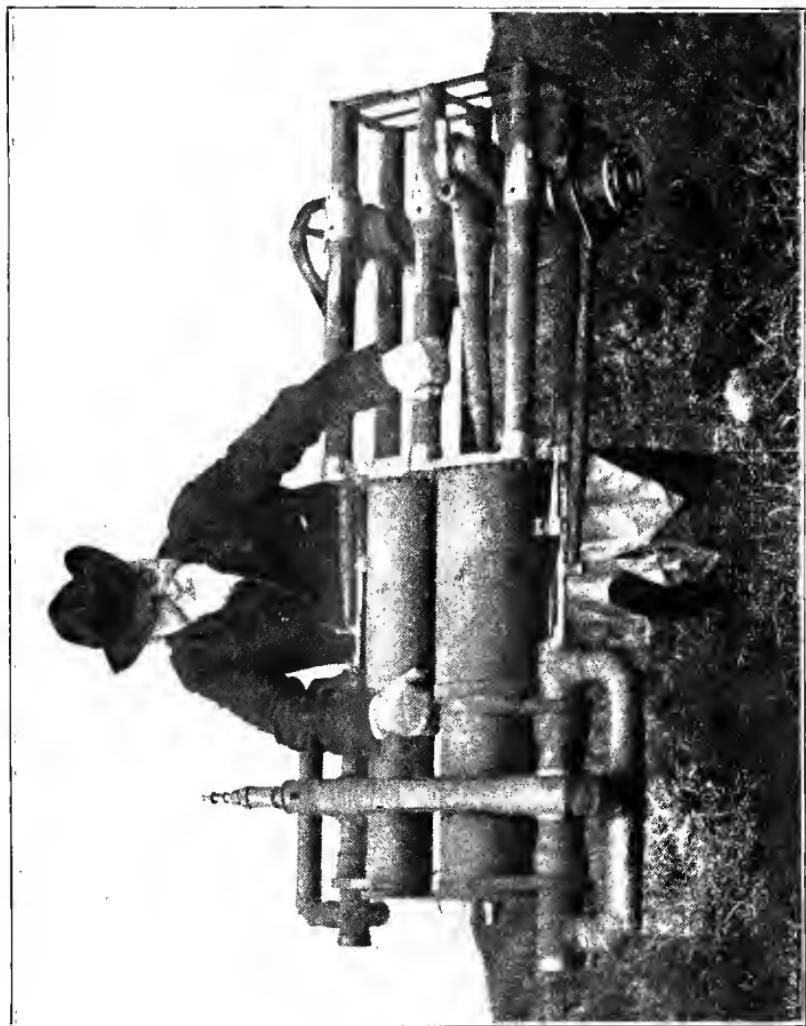
* "Travels in the Air," edited by J. Glaisher, 1871. The veteran aeronaut, who still survives, at an advanced age, received a marked tribute from the Aeronautical Congress which sat at Berlin in 1902.

CHAPTER VI.

WE have seen the science of military aerostation languish from the time of Napoleon's suppression of the school at Meudon, early in his reign.

It was sought to revive ballooning for the purposes of warfare in the African campaign of 1830, but there was no opportunity for making use of the balloons which were sent. The Austrians employed reconnoitring balloons before Venice in 1849 and the Russians in observing from Sebastopol. The French again employed them in the Italian campaign of 1859, but this time the service was in charge of civilian aeronauts, the MM. Godard. Ascents were made from Milan, Gorgonzola, Castenedolo and the Castiglione Hills, but were not very successful, owing to the petty economy of the military authorities. At Solferino a really efficient war balloon arrived on the scene only when the articles of peace were being signed.

It was natural that the Crimean campaign should stimulate inventors to exploit the warlike side of balloons and ballooning. Amongst these and one of the earliest was that of H. G. Luff, who proposed to the War Office a balloon freighted with explosive



[From a Photograph.]

MR. MAXIM HOLDING ONE OF HIS FLYING MACHINE ENGINES; WEIGHT, 300LB.; EFFECTIVE HORSE-POWER, 180. WEIGHT AND POWER CONSIDERED, IT IS THE LIGHTEST ENGINE IN THE WORLD.

compounds, and having a telegraphic communication with a vessel, to be used for attacking forts and towns. The movements of the vessel were to be directed from the balloon, and so guide the balloonist to any desired position for the purpose of letting down explosives. Moreover, plans of fortifications by photographic process were among the important ends to be gained. M. Boboeny proposed to utilise the gas in the balloon for projecting missiles, but it was never done.

The subject received a fresh impetus from the breaking out of the great Civil War in America.

Professor T. S. C. Lowe has since related the story of the formation of the Federal balloon corps, in these words :—

“ Early in the war and after my South Carolina experience, I advanced the idea of forming a balloon corps for the purpose of observing the movements of the enemy. I laid my plans before General Scott, but he laughed at them as visionary. Then I saw President Lincoln, and he gave me a note to General Scott, asking that officer to look at the scheme once more. The result was that eight balloons were fitted out and did service with the Army of the Potomac.”

“ Although shot at thousands of times,” continued Mr. Lowe, “ not one of the balloons was ever hit, save by a minie-ball, and none fell into the hands of the enemy. At the battle of Gaines Hill, the Confederates captured one of the generators, and, taking it to Richmond, endeavoured to put it into working order,

but without success. All our operations were simply for the purpose of information and making maps. Never did we act on the offensive. At Yorktown our midnight observations discovered the evacuation of the town, and led to the battle of Williamsburg, for which General Hancock received his first letter of approval."

On October 4th, 1861, an aeronaut named La Montaine, ascended from McClellan's camp on the Potomac and commended himself to the Federal forces by a successful reconnaissance. He was enabled to observe the position and movements of the enemy and to return to his own line and communicate results announced to be of the utmost importance.*

The balloons used were about 25,000 capacity ; this size was found most suitable. They were constructed of the best silk, the upper part being composed of three or four thicknesses, and so capable of retaining sufficient gas for an ascent a fortnight after inflation. Hydrogen was employed, being generated in the old-fashioned way with scrap-iron and sulphuric acid. Two

* A letter is quoted from General McClellan himself in which he narrates the narrow escape of General Fitzjohn Porter in 1861.

"I am just recovering," he wrote, "from a terrible scare. Early this morning I was awakened by a dispatch from Fitzjohn's headquarters, stating that Fitz had made an ascension in the balloon this morning and that it had broken away and come to the ground some three miles south-west, which would be within the enemy's lines.

"You can imagine how I felt. I at once sent off to the various picquets to find out what they knew, and tried to do something to save him, but the order had no sooner gone than in walks Fitz, just as cool as usual. He had luckily come down near my own camp, after actually passing over that of the enemy.

"You may rest assured of one thing—you won't catch me in the confounded balloon, nor will I allow any other general in it."

balloons and two generators were taken, each on a four-horse waggon, with one two-horse acid-cart. It was found that earthworks could be distinguished at a distance of five miles, while the picquets and supports of the enemy were distinctly seen. Sometimes a telegraph wire was attached to the balloon in order that the aeronaut could at once communicate with the general in command, or even, as was once done, with the Government at Washington. It was even found practicable, for the first time, to take photographs of the enemy's position. At the battle of Chickahominy, during the whole of the engagement Professor Lowe's balloon hovered over the Federal lines at an altitude of 2,000 feet and maintained successful telegraphic communication with General McClellan's head-quarters.

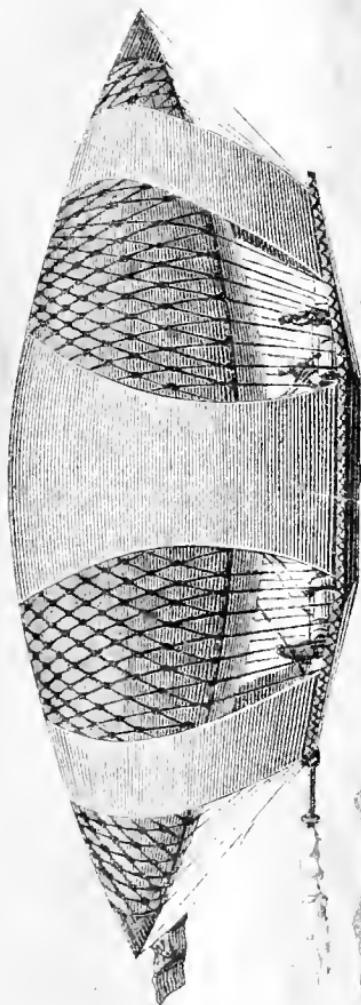
Later in the war, in an attack on Mississippi Island Number 10, Engineer-aeronaut Allen ascended and directed the artillery fire, communicating the effect of each shot.

This reconnaissance was conducted by Professor Steiner, accompanied by two officers, and the result was the discovery that shells had been thrown at too great a range to be sufficiently effective against the Confederate batteries. The defect in mortar-practice was accordingly remedied.

We are told by an eye-witness that during the first two days of the heavy fighting by the Federal left before Richmond, which ended in its retreat from the Peninsula, a telegraph was taken up in the car. The wire being placed in connection with the line to Wash-

ington, telegraphic communications were literally sent direct from the balloon above the field of battle to the Government. It would certainly seem from the point of view of military discipline, or at least etiquette, that the sole official report of the state of affairs should have been received from no one but the officer in command of the army. Consequently, this proceeding came in for severe criticism.

“The balloon staff with McClellan,” says Colonel Beaumont, who visited the Federal army at the time, “consisted of one chief aeronaut whose rank I could never quite make out, but it was not lower than a captain, nor higher than a brigadier; he was a civilian, and by profession an aeronaut; he was very highly paid, the same as a brigadier; and as the military rank, I believe, in America, is in some way attached to and determined by the pay received, I fancy Professor Lowe must have been a brigadier. At any rate he was a very clever man, and indefatigable in carrying out his work. By night or day, whenever the weather gave a chance of seeing anything, he was up engaged on his observations; under him was a captain of infantry, who had been instructed previously at West Point (the American Woolwich) in the art of ballooning. The captain commanded the men, some 50 in number, attached to the machine, and superintended generally every arrangement in connection with its inflation and use. He was also responsible for its transport, and that a due supply of materials was kept ready. The captain never went up himself; indeed he informed me



RUSSELL THAYER'S AMERICAN MILITARY AIRSHIP.

that he liked the work below best, and confined himself entirely to it. Under the captain were a proportion of non-commissioned officers, who knew more or less of the management of it, and the men who, besides having a sort of reverential awe of the machine, knew nothing whatever about it. Either one or two sentries were always on guard, detailed from the captain's party, who had the strictest orders to allow no unauthorized person to approach."

It is further interesting to know that each regenerator required four horses to draw it, and each balloon with the tools, etc., four horses.

Encouraged by these examples, the English military authorities resolved upon making some experiments at Aldershot in July, 1862. Henry Coxwell, the aeronaut, was employed to bring one of his balloons, which was filled at the gas-works, and several captive ascents were made. Colonel Beaumont, R.E., reported that no large movement of troops could take place within a radius of ten miles without being seen. But it was not until June, 1871, that the Government appointed a committee, consisting of Cols. Beaumont and Grover and Sir F. Abel to enquire into the use of balloons in warfare.

Col. Grover, R.E., in 1862, thus enumerated the chief objections urged against a practical application of balloons in warfare.

i. The chance of their being struck by the enemy's projectiles and caused to fall suddenly, in consequence of the escape of gas.

2. The size, weight, and consequent deficiency of transport attendant upon balloons with sufficient buoyant power to admit of their being attached to the earth by guy-ropes.
3. The difficulty of providing gas for their inflation when in the field.
4. The difficulty of attaching to the army experienced aeronauts for the purpose of inflating the balloon, regulating its ascents and movements in the air, and taking general charge of it on service.
5. The dangers incidental to balloon ascents in general, even when undertaken by experienced and professional aeronauts.

Most of these objections are now seen to be, at an interval of forty years, out of date. Every first-class fighting Power now has a corps of military balloonists: and an account of the British establishment has emanated from the pen of one of its officers.*

It was in 1866 that M. Delamarne designed a cylindrical balloon, terminating in its anterior part by a disc termed a *taille-vent*, for resisting the pressure of the air. On each side of the cylinder was fixed a screw with three blades, which derived its movement from a shuttle worked by the aeronaut in the car. A rudder of large dimensions completed the apparatus.

The first trial took place in the Luxembourg Gardens. The inventor had promised that he would guide the course of his machine in the air, whatever

* Lieutenant H. B. Jones, R.E.

was the force of the wind. But in spite of his promises the machine rose slowly, greatly inclined, and, defying all Delamarne's manoeuvres, soon followed the first aerial current it encountered. On a subsequent occasion the inventor repeated his attempt from the Champs de Mars, in the presence of the Emperor Napoleon III., but this time the issue was much more regrettable. For, in the manœuvres of departure, one of the blades of the screw tore through the material of the balloon and made a large rent in the side which could not be repaired. This proved Delamarne's last essay in atmospheric navigations, but not his last aerial voyage! For he offered in 1870 to conduct a balloon-post in the provinces. Here, however, his usual bad luck pursued him, and the unfortunate aeronaut could not avert his descent in Prussia with his despatches and carrier pigeons.

Amongst other projects in France which belong to the ante-bellum epoch, may be mentioned those of Barnout, of de Luze, of Jullien, and of Camille Vert, the latter of whom devoted no less than twenty years of his life to prove the excellence of his system. A more curious device, which was seriously proposed about this time, was that of a certain architect, who wished to tow a captive balloon by the aid of a pulley running on a horizontal cable from Paris to St. Cloud. This seems to have been the forerunner of a long line of balloon railway projects up to our own decade.

Another stupendous attempt to solve the problem of a dirigible air-ship was by M. Lassie. It took the form of a metallic cylinder some 90 feet in diameter and nearly 900 feet long. Four sails or fins were fastened to the side in the form of spirals, running the entire length of the machine. To produce the movement of rotation, 640 men, placed in the centre of the cylinder, were to pace—treadmill fashion, or as squirrels in a cage—at the signal given by a whistle.

At the outbreak of the Franco-Prussian War in July, 1870, there were in Paris many experienced aeronauts, including Tissandier, de Fonvielle, Nadar, Jules Durouf (about whom we shall speak later) and Eugene Godard, who had made no fewer than 800 ascents. The subject of military ballooning was naturally raised: and received a luke-warm support from the Imperial Government, which was far too distracted seriously to consider any scientific matter—even the true science of the commissariat in war time. Before anything could be arranged, there came the disaster of Sedan, which was followed in a few days by the close investment of Paris. The new Government at once addressed themselves to the aeronauts, with a view to opening up aerial communication with the exterior country. Six balloons were overhauled, all in indifferent condition, the worst being the one Napoleon III. had intended for Solferino, but which had arrived on the scene of the battle a day too late. M. Tissandier tells us that

nobody seems to have known how to repair this balloon, known as "L'Imperial." However, they were all got together, the besieged Parisians hailing the project with the joy of children. Here at last was a chance of putting into execution the very idea for which Montgolfier, the inventor of the balloon, had really intended his invention.

The first ascent of the siege was made by M. Durouf on September 23rd. He carried a large number of despatches, and, after a three hours' journey landed safely near Evreux. He was followed on the 25th by M. Mangin; on the 29th by Godard, jnr., and on the 30th by Gaston Tissandier, who has given us a spirited account of his voyage.

The success of these aeronauts in escaping from the capital, and the hands of the Prussians, encouraged the Government to establish a balloon post on a regular system. Immediate steps were taken for the manufacture of a large number of balloons under specific conditions, as rapidly as possible. Making the vessels proved, however, an easier task than finding captains for them. Experienced aeronauts were few, and it must be remembered that when once they left Paris there was no returning. That was the radical fault of balloons; one could not elect the place of one's descent. In this emergency, it was decided to invite the assistance of such sailors as were in the capital, as belonging to a class whose training had rendered them familiar with operations and dangers not dissimilar from ballooning. The

appeal met with a satisfactory response; many excellent mariners offered their services: they were given all possible instructions, and a large number of successful ascents were carried out by these brave French tars. The remark of one of them deserves to be memorable. "Our topsail is high, sir, and difficult to reef; but we can sail, all the same, and please God, will arrive in port."

The plan of employing acrobats from the Hippodrome was attended with less success. In several instances, we are told, they directed their skill, when in a tight place, to slip down the guide rope to earth, leaving the passengers and despatches to look after themselves. But, on the whole, the balloon service was distinguished by singular ability and precision. From September to January, 64 balloons were sent off, and of these 57 fulfilled their mission, and the despatches reached their destination. The total number of persons who left Paris was 155, the weight of the despatches was 9 tons, and the number of letters 3,000,000. As for the speed of transit, it varied from 20 to 50 miles an hour, and, in one instance, as high as 80 miles.

Gambetta left by the "Armand Barbes" (every balloon had, of course, a name) on the 7th October. When at too low an altitude he was immediately fired on by the Prussians, and narrowly escaped being hit by a bullet.

On the 27th October, the "Bretagne" fell, owing to bad management, into the hands of the enemy near

Verdun ; on the 4th November the "Galilee" had a similar fate near Chartres ; and, on the 12th, the "Daguerre" was shot at, brought down and seized a few leagues from Paris. The loss of three balloons within a little more than a fortnight alarmed the Government. It was obvious that the vigilance of the enemy had been aroused, and whenever a balloon was seen, advices were telegraphed along its probable line of flight, and the swiftest Uhlans were put on the alert in the hope of capturing it. The danger had vastly increased, since a new rifled gun of enormous range had been made by Krupp for the purpose of firing shells at the aerial transports. One of these was about this time set up at Versailles. For these reasons the Government resolved that, in future, balloon departures should take place at night. At the same time the darkness added greatly to the difficulties of the voyage, and several of these nocturnal ascents were attended with singular adventures.

About midnight, on the 24th November, the "Ville d'Orleans" rose from Paris with an aeronaut and one passenger. The wind blew from the north, and it was hoped the balloon would descend near Tours. But in a short time the voyagers heard a sound below them which caused them both deep apprehension ; it was the lashing of breakers on the shore. At the time of this discovery they were in a thick mist ; when, at daybreak, this cleared, they found themselves suspended over the sea out of sight of land. Several vessels were perceived, and to these they tried to

signal, but were not answered. One vessel, indeed, responded ; but it was by firing at them. Scudding now rapidly to the north, they were giving themselves up for lost, when they came in sight of land to the eastward. Before they could gain it, they descended rapidly from loss of gas, and their ballast being gone, they were obliged in despair to throw out a bag of despatches. This expedient saved them, the balloon rose, encountering a westerly current which carried them to shore. What part of the world they were in at their descent they had no notion ; the ground was covered with snow, and they fainted on getting out of the car. When they recovered they made their way along on foot with great exertion. The first living creatures they saw were three wolves, who, however, did not molest them. After a painful walk of several hours, they found a shed where they rested for the night, and the next morning continued their march, coming across another hovel, which showed them that the country was inhabited. Shortly afterwards two woodmen came in, but as neither party could understand the other, it was only by one of the peasants pulling out a box of matches marked "Christiania" that the Frenchmen could guess where they had fallen. They were in Norway. They met with great kindness, and although the balloon escaped when they fainted, it was subsequently secured, together with all the contents of the car. The despatches, too, reached their destination.

A week later, on the 30th of November, two fateful



THE "VILLE D'ORLEANS" IN NORWAY.

ascents from beleaguered Paris were made. The "Jacquard" rose at 11 p.m. in charge of a sailor named Prince, whose new-found aeronautic zeal was so great that, as the ropes parted, he cried out, "Je veux faire un immense voyage : on parlara de mon ascension." He was not, alas, to be balked of his ambition. Driven by a south-easterly wind he passed over the English Channel, where he was seen by some English vessels. While over the vicinity of the Lizard, he dropped his despatches, some of which were afterwards picked up on the rocks. Thus lightened, the balloon rose to a great height, disappeared over the Atlantic billows and was never heard of again.

The second balloon, the "Jules Favre," started at half-past eleven with two passengers. Only by a miracle did it escape the fate of the "Jacquard." The wind blew from the north, and the aeronauts fancied they were on the way to Lyons. Long enveloped in fog, they emerged at daybreak, and saw beneath them an island which they supposed to be in a river.

They were grossly deceived. It was Hoedic in the Atlantic!

The Frenchmen were driving furiously out to sea ; but in front of them lay, as a forlorn hope, the larger island of Belle Isle. It was seen that they would have to pass one end of it where it was very narrow, and that they must either land on this strip of land or be lost. They tore the valve open with frantic energy, caused the balloon to descend some thousand feet in a

few minutes, and luckily succeeded in striking the land. Albeit the shock was terrific ; three times did the balloon bound into the air, and at last caught against a wall, precipitating the occupants of the car to the earth. They were badly injured, but received great attention from the people of the neighbourhood. The father of General Trochu resided here, and ordered them to be brought to his house.

On December 15th the “Ville de Paris” was so unlucky as to fall at Wertzlar in Prussia ; and four days later the “General Chanzy” was also made captive at Rothenburg in Bavaria. On the morning of the 28th January, the “Richard Wallace,” which rose from Paris the previous night, was observed at La Rochelle, approaching the sea and almost touching the ground. The people shouted to the aeronaut to descend, but instead of doing so he threw out a sack of ballast, rose to a great height, and soon disappeared in the western horizon. Doubtless the poor fellow had lost his senses on seeing the danger which confronted him. This almost completes the story of the ballooning during the siege of Paris. It was the last ascent but one ; that on the next day bore intelligence to the provinces of the conclusion of an armistice.

These aerial voyages had solved the problem of communication from Paris outwards. The other problem of communication inwards from the provinces was hardly less important and much more difficult. It required a particular direction of current, and although M. Tissandier made several attempts

he failed, and the return of the balloons was observed to be impracticable. Of the projects which were offered to the Government to encompass the desired end, some were amongst the wildest and most visionary that ever entered the brain of man. One balloon took out some trained dogs, which it was hoped would find their way back again, but they never reappeared.

The actual method by which the difficulty was solved deserves, we think, a place in a work dealing with aerial navigation. The return post was effected by means of carrier pigeons, which having been taken out of Paris in balloons, were let loose in the provinces to find their way home. There existed in Paris a "Société Colombophile," and after the departure of the first balloon the leading spirits of this body approached General Trochu and proposed that an attempt should be made to combine the outward balloon post with a return service by pigeons. The second balloon carried three birds, which came safely back sixteen hours later with news from the aeronauts. The return of eighteen more despatched in following days confirmed the practicability of the scheme. Thereupon the service was regularly organised, and was carried on, with a fair amount of success, throughout the investment of the capital by the enemy. As the despatches were required to be very small and light, recourse was had to microscopic photography. By this means sixteen folio pages of print (32,000 words) were reduced to a pellicule 2 inches long, $1\frac{1}{4}$ inches wide, and weighing about three-quarters of a grain!

The messages were destined for residents of Paris, and came from all over France. Here are a few samples :

Dépêches a distribuer aux destinations : *Pau. 26 Janvier.* A. Focher, Rue Chaussée d'Antin. Madeleine accouchée heureusement hier. Bien beau garçon.

Biarritz, 1 Février. A Martin, 68 Rue Petites Ecuries. Sommes à Biarritz, bébé complètement remis, embrace papa, doloureusement impressionnés événements.

A. Fant. Besoin d'argent, demande Masquier.

A. Perier. Tous parfaitement bien, trouveras charbon dans cave.

Each pigeon carried twenty of these tiny collodion leaves, carefully rolled up and placed in a quill. They contained sufficient printed matter to fill a large volume, and yet the weight of the whole was only 15 grains. When the first bird arrived at his cot in Paris, his precious little burden was taken to the Government Office, the quill was cut open, and the gelatinous leaves extracted. Placed in an enlarging optical apparatus, similar to a magic lantern, the messages were thrown on a screen, copied from thence, and sent to their destination. The charge was 50 centimes a word. The despatches were not entrusted to one pigeon, but repeated by others in order to provide against accidents, which were very common. The Prussians were powerless against the winged messengers, although an attempt was made to chase them with birds of prey; but dense fogs and severe cold played havoc with the birds. There were sent out of Paris 363 pigeons, of which only 57 returned, some having been absent a long time.

Such is a brief narrative of this aerial post. It was beyond question a marked success. Although it could not save France or her capital, yet it was an immense boon to the besieged, for it established during the whole of the siege that communication with the exterior which would otherwise have been impossible. Had the cause of the French been less desperate the strategic advantage the correspondence would have imparted might have even turned the scale against the enemy.

During the war an incident of great dramatic interest is narrated as having occurred in full view of Paris. A French war-balloon, the "Intrepide," was floating in the air 3,000 metres above the fort at Charenton. Almost at the same time a second balloon, also flying the French colours, was observed on the horizon. When within a short distance of each other, a loud report was heard high in the heavens, followed by a series of explosions.

"The voices," writes an eye-witness, "were at first thought by the cheering garrison below to be demonstrations or signals of victory, until one aeronaut was seen to fling himself into the network of his balloon and to cling to its sides. During this time the other continued discharging shots which were traced in the sky by the luminous effects.

"The 'Intrepide' descended rapidly, and it appeared to the spectators below that some incomprehensible event had taken place above. Suddenly the French flag of the second balloon was removed, and a

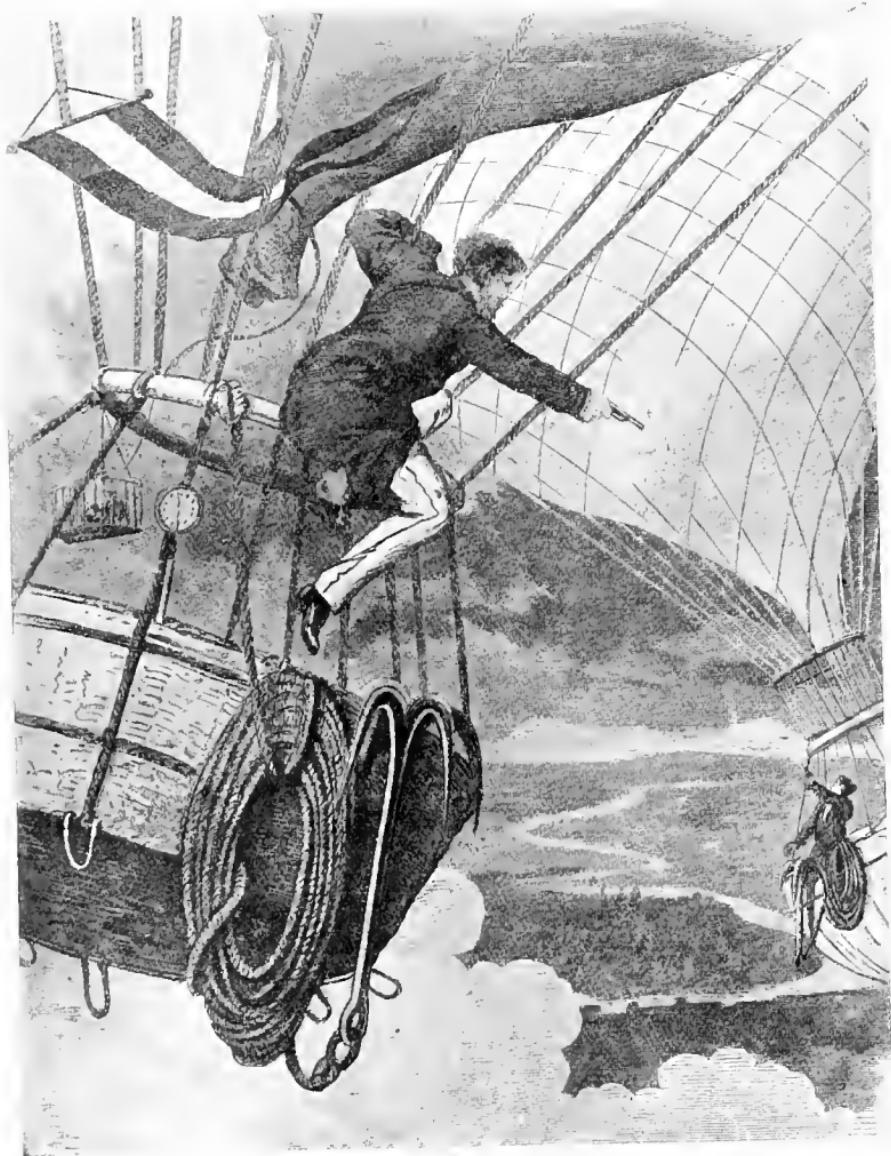
black and yellow standard was perceived to be floating in its place.

“The cry went up ‘Treason’—it is a Prussian balloon! The Prussian balloonist has fired on the ‘Intrepide’! The ‘Intrepide’ was, however, safe, for her aeronaut was seen to descend rapidly in his car and the balloon nearly to reach the earth. He cast out the ballast and re-ascended, having hastily closed the hole made in his balloon by his adversary. Shots were instantly fired from the ‘Intrepide’ into the Prussian balloon, which, losing all power, fell with terrific velocity. A detachment of Uhlans who were in the plain and had been following the course of the exciting aerial combat, rushed forward and surrounded their champion. He was carried off injured, but how great were his injuries none ever knew.”

Mr. Durouf,* who was the first aeronaut to escape from Paris during the siege, was destined, four years later, to a perilous adventure, which was shared equally by his wife. During the siege, after he had quitted the capital, he was sent to Lille for the purpose of attempting a return, but the armistice intervened, and Durouf found himself appointed by the Commune a captain in their balloon service. But the Commune was duly crushed and Durouf found himself a prisoner. He was tried by a Council of War; but, in consideration of what he had done during the war, he was unanimously acquitted.

At Calais, on August 31st, Durouf and his wife had

* His name was originally Dufour.



A DUEL IN THE CLOUDS.

arranged to cross the Channel. A vast crowd was assembled, it being a festive occasion, but the wind blowing hard from the south-west, it seemed futile to attempt the journey. Accordingly, after having taken council with some scientific persons among the spectators, Durouf decided to keep the balloon in a state of inflation in order to see if the wind should alter its course but at present to desist from the attempt. He thereupon retired to his hotel, without reckoning with the vast assembled mob. Their dissatisfaction very quickly reached the ears of himself and Mme. Durouf, accompanied by provoking insults. At last it grew so unbearable that he abruptly quitted his friends at the hotel, with the remark that he "would show the Calaisians that he was not afraid to die to please them." The couple thereupon ordered the car to be re-attached, in spite of all the expostulations of the authorities and his friends, and hurriedly got inside. The lady was even more zealous for the ascent than her husband, although it foreshadowed almost certain catastrophe. She was without bonnet or cloak ; they carried nothing to eat or drink and only a few sacks of ballast, not aggregating 200lbs. At seven o'clock the balloon shot upwards, and ten minutes later the foolhardy pair were out of sight in the growing dusk, travelling at a terrific rate towards the open sea.

A sentiment of horror spread throughout France and Europe when the news of this rash proceeding became known. During three days the public gaze

was directed towards that part of the ocean where the Duroufs had last appeared. At length a telegram sent from Grimsby relieved the general apprehension. It appeared that the two courageous aeronauts had been saved by the crew of an English fishing smack, on the Skager-rak. Durouf and his wife were almost perished from exposure combined with excessive thirst. The crew of the smack were pursuing their usual avocation at the south-east end of the Dogger Bank when they perceived the balloon high in the air going towards the Norwegian coast. The car, descending, was soon in a slanting position on the surface of the waves, and as there was a high sea, rushed along, drenching the unfortunate occupants. Having got up their fishing gear, the smack immediately gave chase and ran before the wind, in the wake of the drifting balloon. After a pursuit lasting an hour and a half the vessel came within a short distance, when the crew got out and the captain and mate rowed after the distressed aeronauts. The car kept rising out of the water and was sometimes entirely covered by the waves. Its progress being thus arrested, the boat gained upon it. The balloon grapplings seemed to have got fouled for the rope was cut and dragging along the surface of the sea. The man made two attempts to reach the rope, but failed, and from the irregular motion of the balloon there was great danger of their own craft being upset. After several efforts they succeeded in getting Durouf and his wife, who were now half-drowned and thoroughly

exhausted, into their boat. The balloon upon being detached from the car floated off in a north-easterly direction. The adventurous couple landed at Grimsby, September 4th, being heartily greeted by hundreds of fishermen and other spectators.

It was but an act of poetical justice that Calais should have immediately subscribed a goodly sum for Durouf and his wife. This money the aeronaut applied to the construction of a balloon to which he gave the name of that city. He also made a successful ascent at the Crystal Palace, and the "Incident Durouf" was the means of awakening the Government of M. Thiers to a tardy recognition of the services rendered by this and other aeronauts of the siege. In addition to certain honorific recompenses by the Government the authorities of Paris ordered a special medal to be struck, a copy of which was presented to each of the intrepid men who had taken part in the system of aerial post during the blockade of the capital by the Prussians.

CHAPTER VII.

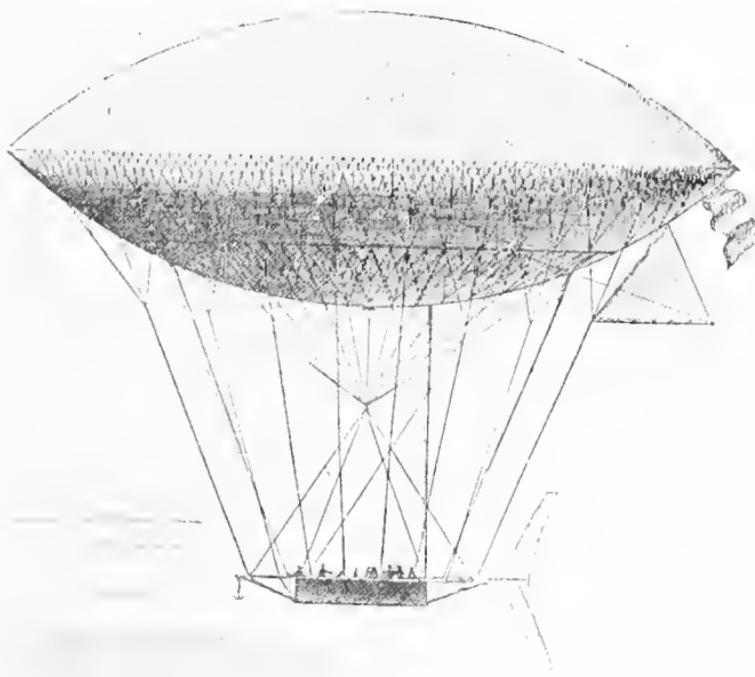
As was to be expected, these striking events of the Siege of Paris revivified the whole subject of aerostation, and the Government's pecuniary grants and prizes induced many inventors to devote their attention to the production of a dirigible balloon.

In October, 1870, M. Dupuy de Lome, naval architect to the French Government, obtained a grant of £1,600 for the purpose of experiments, and proceeded to construct an apparatus, which was in progress when the Communist insurrection broke out and stopped the proceedings.

Peace being at length restored, M. de Lome resumed the work at his own cost, and the trial of his device was made on February 2nd, 1872. The balloon was elongated, 120 feet long and 50 feet in diameter, containing 122,000 cubic feet, and was filled with hydrogen. It had a triangular rudder, and the car was fitted with a screw propeller of two sails, 30 feet in diameter, intended to be worked by four men, a relay gang being also taken up to relieve them. The inventor regarded it as essential that the balloon should preserve its form notwithstanding any escape of gas,

and in order to ensure this he placed a smaller balloon inside the large envelope which could be filled with air from the car when required.

The ascent was made at Vincennes, thirteen persons besides M. de Lome rising in the car. The inventor



DUPUY DE LOME'S AIR-SHIP.

had all along declared that he did not aim at attaining any great independent speed ; the important point was to get such moderate control over the course as would render it possible for balloons to return into Paris. He believed that a motion through the air of about 5 miles (8 kilometres) would suffice for the end.

Shortly after leaving the ground, the screw was put in motion, and on the rudder being taken in hand its influence was at once observable. The wind was high, blowing from the south-west, with a velocity varying from 27 to 37 miles an hour, and all that could be hoped for was to produce a moderate deviation in the direction of the flight. This was accomplished, as, when the screw was put to work and the head of the balloon set at right angles to the wind, a deviation was obtained of ten or eleven degrees, showing an independent motion through the air of 5 to $7\frac{1}{2}$ miles an hour, produced by the machinery. The descent was made in safety about 90 miles from Paris.

It was subsequently recognized that M. de Lome and his machine had really made little practical advance on M. Gifford's achievement. Nevertheless, it was now rendered indisputable that a buoyant aerial screw ship could be constructed which should have a form of small resistance, which should be stable and easy to manage, and which should obey her rudder. There then remained only the question, what power was necessary to give such a vessel a certain speed through the air, what amount of power could be carried, and how that power might be applied.

The year 1870, which was distinguished in at least one country by reason of the extreme activity and utility of ballooning, was also marked by the death of the most distinguished English aeronaut of the day, Charles Green. This ingenious person had during a long life of nearly eighty-five years contributed largely

to the enlightenment as well as the amusement of the public by his aerial flights. His aerial chronology dated as far back as July 19th, 1821, when he made his first ascent in a balloon inflated with coal gas, which he substituted for hydrogen. This was one of the great outdoor sights provided for the people in St. James's Park on the Coronation Day of George IV. Up to that time, balloons had, as we have seen, been inflated with hydrogen gas by a slow chemical process made in casks, whence it was conveyed by hose into the balloon. Coal gas proved more economical as well as certain, and Green's success vastly increased the facility of balloon ascents. During the next thirty years Green and ballooning became almost synonymous, he himself making no fewer than 142 ascents from London alone, while there were at least ten persons of that name, real or assumed, who ascended in balloons.

Soon after the war in France there rose into celebrity the name of Pénaud.

Pénaud was an inventor of great ingenuity, who began the study of aeronautics at an unusually early age. He produced an artificial bird, and followed this up with a flying screw. In 1871 he invented an aeroplane, with automatic equilibrium, which he called a planophore. The apparatus was publicly exhibited in August of that year to a group of members of the French Society of Aerial Navigation, in the Garden of the Tuilleries, and the model, guided horizontally by a small vertical rudder, flew several times in a circle, falling gently to the ground near its starting point,

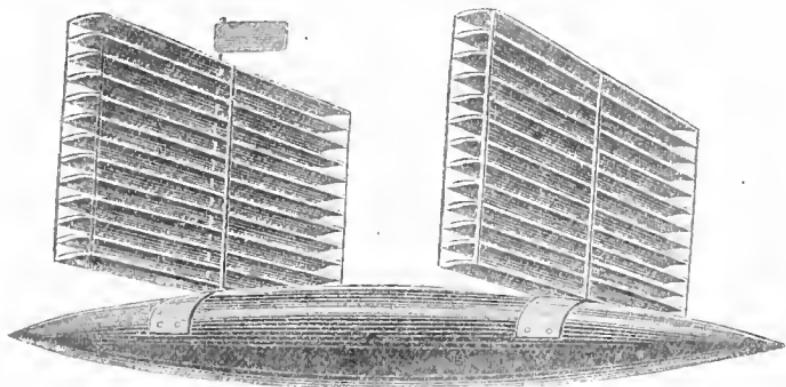
when the motive power was exhausted. The speed was about 12 feet per second, or about the same as that of insects with the same relative surface in proportion to their weight. The power expended was reckoned by Pénaud to be at the rate of one horse-power for each 81lbs., although M. Touche, who has examined the calculations, makes it about thrice this amount. This result is greatly inferior to that obtained by Maxim and Langley, owing, perhaps, to the greater proportion of surface and weight.

Pénaud subsequently proposed a machine capable of taking up two men, but the funds were not forthcoming ; he was subjected to much criticism and misrepresentation. In the end the young man lost courage, his health failed, and he died in October, 1880, in his thirtieth year.

Contemporary with Pénaud was a young engineer, named Bouvet. Adopting certain ideas first promulgated by Pilatre or Rozier on the ascent and descent of balloons by altering the temperature of the air or gas, added to those theories of Mensnier concerning air currents, he attempted about this time certain interesting experiments. But the inventor was not destined to make an ascent according to his plan, dying in the midst of his experiments. It is believed that his system possessed great merit, and would have accomplished a notable end in perfecting ordinary vertical aerostation, if it did not solve the great aerial problem.

The idea of availing oneself of the aerial currents in order to gain a certain point on the earth's surface, has

provoked numerous aeronauts to find some means of inducing at will the ascent and descent of their aerostats. Among these in later times was Ribeiro de Souza, who applied large inclined planes to his balloon; Bowdler, L'Hoste, and many others, who invoked the aid of a horizontal screw fixed to the cross-bar of the circle or to the car itself; Capazza, whose idea resembled that of Jobert, strove to maintain an equipoise



PHILLIPS'S AERIAL MACHINE.

by means of a parachute attached to the balloon by a cord, serving the purpose of ballast. Indeed it would not be practicable even to mention all the persons who sought to obtain a common result by physical rather than by mechanical means. One scheme was that of injecting steam into the balloon at a pressure of two or three atmospheres, and so, by the artificial dilatation thus produced, obtain a rapid change of level.

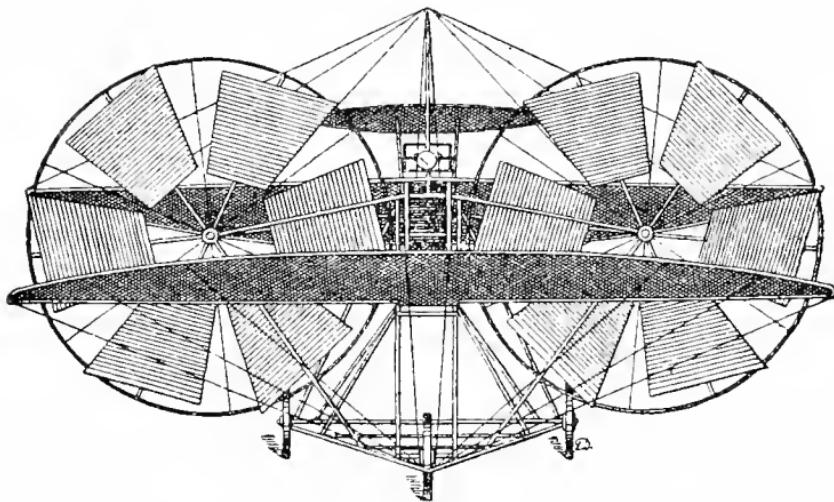
A very singular invention owed its origin, in 1878, to one Cayrol-Castagnat.

Beneath a balloon of over 300 cubic feet of capacity, a swimmer was suspended by the middle. He was furnished with large wings of light cloth, with which he beat the air in bird-like fashion. The swimmer was, of course, Cayrol-Castagnat himself, and he made numerous exhibitions in a captive balloon, delighting the youth of Paris, and earning for himself the proud title of "Founder of the School of Aerial Natation." The authorities, however, would not allow a free ascent of the balloon, and so the life of the inventor was spared to his friends and family. He himself always firmly believed that he had solved the great problem of aerial navigation.

In Germany, the flying machine invented by H. De Vogt in 1874 belongs to a familiar type. A frame or wing, nearly horizontal and slightly convex in form, constitutes the elevating and propelling means. This frame is strengthened by struts and stays, and is fitted with feathers which overlap one another, thus holding the air on the downward stroke, but opening to allow the air to pass between same on the upward stroke. By the action of a piston-rod a reciprocal up and down motion of the frame is obtained. The boiler and engine is carried in a boat, while a kite fitted round the boat prevented rolling.

"Thomas Moy's Aerial Steamer" was tried at the Crystal Palace in June, 1875. The supporting surface consisted of two aeroplanes, in front and behind the

propelling aerial wheels. They were of linen, stretched upon bamboo canes, and set at an angle of ten degrees with the horizon. Between the two supporting aeroplanes were placed two propelling aerial wheels, six feet in diameter, each provided with six blades. At first these were made of thin laths, but were afterwards constructed of cambric. The blades were, by an ingenious arrangement, caused to change their angle as they



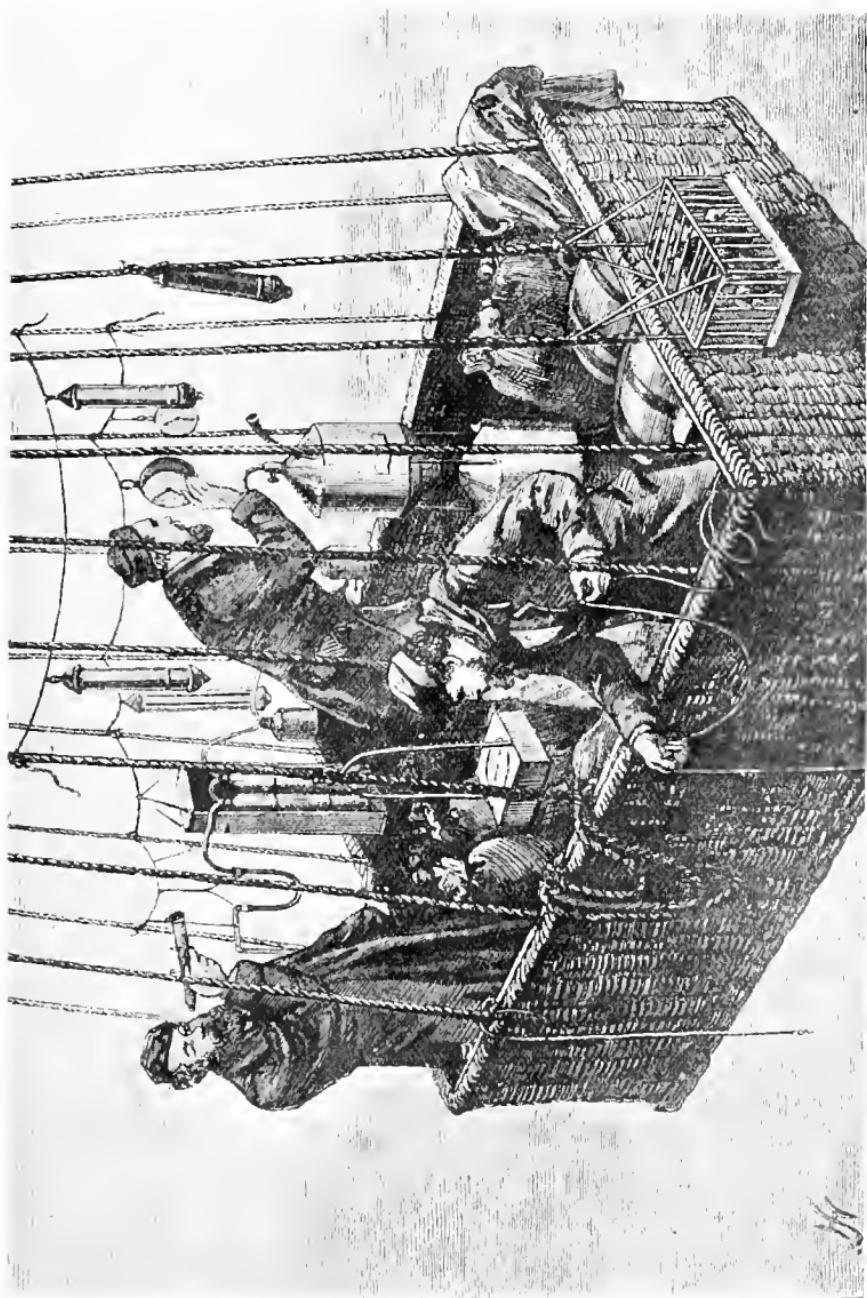
MOY'S AERIAL STEAMER.

rotated. The steam engine was a miracle of lightness, having a diameter in the cylinder of $2\frac{1}{8}$ inches, and a stroke of 3 inches with 520 to 550 revolutions per minute. It weighed with the boiler 80 lbs. and developed fully three horse power, the whole machine being mounted on three small wheels. The inventor reckoned that at a speed of 35 miles an hour it would be able to rise from the ground and glide upon the air. After some preliminary tests, a path round one of the

fountains at the Crystal Palace was selected, which had a diameter of some 300 feet ; a pole was erected at the centre of the fountain and two cords were run from the top of the pole to each end of the machine, in order to keep it at a uniform distance from the centre. The gravel had been rolled and steam was got up ; but it was soon found that the path was still too rough, for it shook the steamer and greatly increased the traction. A board walk was therefore laid over the path, and again steam was got up and a good run was made around the fountain, at the rate of 12 miles an hour, the machine being wholly propelled by the action of the aerial wheels upon the air. But a speed of 35 miles would have to be attained before it could hope to leave the ground, and this feat, therefore, the spectators did not see. To secure greater speed might require a larger and costlier apparatus, and so the whole project had to be abandoned.

Recognising, after repeated failure, the apparent inefficiency of man himself and unaided to actuate wings or the screw principle, several inventors had long begun to devise motors, to which the objections heretofore urged against steam could not be taken. The first of these was the apparatus of Pomes and de la Pauze in 1871, which was to be worked by a gunpowder machine. But, although carefully elaborated, only the model was ever built.

Some years later, however, an interesting series of experiments was made by de la Pauze with another flying machine. The car, or boat, was constructed of



THE FATAL ASCENT OF THE "ZENITH."

a framework of light weldless steel tubing, stayed or trussed together. This frame was covered with oiled silk. A large aeroplane was balanced on the car, which could be inclined either up or down. Propellers were mounted on ball-and-socket joints, and could thus be employed for steering as well as for propelling. The car was mounted on springs joined to wheels and the machine, when started on a level road, was to rise on the aeroplane being inclined upward.

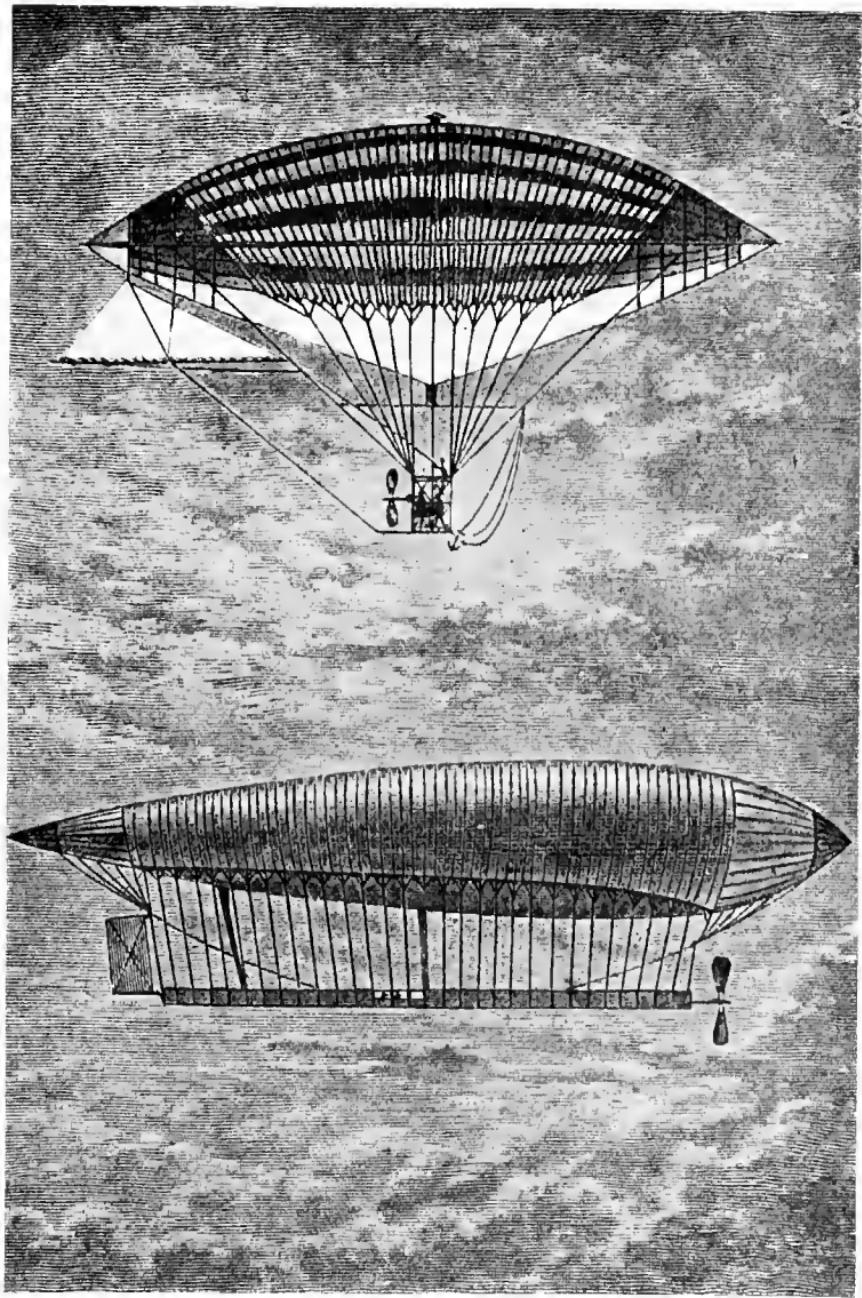
An apparatus which was thoroughly experimented with, some years being devoted to attempts to put it into practical operation, was that of Felix du Temple, a French naval officer. It consisted of two fixed wings of silk fabric, stretched by curved spars of wood or metal, firmly attached to a car containing the motor. In front of this was affixed a screw with a pivoted axle, in order to draw the apparatus forward. A horizontal tail hinged at the car was intended to regulate the angle of incidence, and of the flight of the machine, while a vertical rudder, under the tail and separate from it, was to steer to the right or left. The car was boat-shaped. In spite of all the expense incurred, no adequate motor could be found for the machine, and in 1876 the scheme was abandoned.

From time to time ascents had been undertaken by zealous men for scientific purposes, in imitation of Robertson, Gay-Lussac and Glaisher, whose voyages are of almost classical celebrity. On the 23rd March, 1875, the balloon *Zenith* accomplished a memorable voyage of aerial discovery, having in the

car Messieurs Albert and Gaston Tissandier, Sivel, Crocé-Spinelli, and Jobert, and maintaining itself twenty-two hours and forty minutes in the air. Before landing in the Department of Landes, they traversed the Gironde, and passed a large part of their time observing lunar phenomena. A month later the same balloon rose from Paris, with three out of the five aeronauts just named. Reaching an altitude of over 2,000 feet, the trio began to feel acutely the effects of the rarefaction of the atmosphere. In vain they sought to use the bags of oxygen they carried ; slowly they lost consciousness ; and when the ill-fated *Zenith* re-descended towards the earth, Sivel and Crocé-Spinelli were dead from asphyxiation. The shock on striking the soil was so rude as to break the instruments, yet Gaston Tissandier escaped serious injury, alone surviving to tell the tale. The descent was made in the Department of the Indre, some hours having been spent in the air.

Since this catastrophe few—very few—voyages have been undertaken solely in the interest of science.

The Franco-Prussian War awakened our military authorities anew to the importance of ballooning. On July 25th, 1872, a highly interesting experiment was made at Woolwich with the balloon, "City of New York," the apparatus, the invention of Mr. Bowdler, consisting of an aerial screw, fashioned of zinc, and attached to an iron frame. The diameter of the screw was 3 ft., and the estimated speed was from twelve to fourteen revolutions a second. While in mid-air it was



TISSANDIER'S ELECTRIC AIR-SHIP.

KREBS' AND RENARD'S AIR-SHIP.

put in movement by the inventor, but did not produce the expected effect, owing chiefly to the round shape of the balloon offering too great resistance to the air. It began to turn, however, on its own axis, first to the right and then to the left, according to the inclination of the rudder.

As the balloon was, in addition, furnished with a horizontal screw, to propel it upward, this was put to work, the balloon rose and finally ascended, when the motion ceased. This was regarded as a useful discovery by the military authorities of the day. However, the fit passed off, and nothing was done for eight more years. In April, 1879, an official Balloon Committee, consisting of Colonel Noble, R.E., Sir F. Abel and Captain Lee, R.E., with whom was associated Captain Elsdale, R.E., and Captain Templer,* of the Middlesex Militia, the latter having had considerable experience in ballooning. Experiments were conducted at Woolwich, and four balloons were made by the Royal Engineers, of specially woven fine calico, varnished. A portable furnace and boiler for the manufacture of hydrogen gas was devised, similar in principle to the one used by the French in 1793, "but," reported Mr. Coxwell, "the apparatus did not prove satisfactory."

Indeed, the authorities seem to have proceeded in an unbusinesslike, haphazard and unenlightened sort of a way in this first undertaking. A few days after the inauguration of the new system an unlucky adventure happened as one of the war balloons was being towed,

* Now Colonel Templer, chief of the Ballooning Corps.

attached to a cart. The cable parted and the balloon disappeared in the clouds. In October, 1879, one of the balloons was tried at a review on Woolwich Common, but the wind was unfavourable. The following year a successful ascent was made at a Volunteer review at Brighton, and in the early autumn of 1880 a whole company of Engineers (the 24th) repaired to Aldershot for instruction in ballooning, and many experiments were there made.

As regards the danger of military balloonists, in 1880 the Siege Operations Committee made an experiment at Dungeness, with rather disastrous results for the balloon. An 8-inch howitzer was directed towards a captive balloon 2,000 yards distant and 800 feet high. The first shot was unsuccessful, the exact range not being known. The second shell, however, burst just in front of the balloon and tore it open. But even then it took fifteen minutes to descend, so that the aeronauts would have been safe. Bullets made of spongy platinum have also been suggested as a means of igniting the hydrogen in a balloon by mere contact. But the danger, after all, is as yet not greater to a military aeronaut than it was a century ago, in spite of the long-range guns of Krupp.

It was in 1879 that, thanks to M. Gambetta, the Aeronautic School of Meudon was reorganised. It became, however, a simple factory for the construction of captive balloons for military purposes. Up to the close of 1881 this dépôt was carried on without accomplishing anything else than the preparation and

distribution of balloons and their material ; but at that period the idea of constructing a dirigible balloon propelled by electricity occurred to the directors of the establishment. They procured from the Government the necessary funds. The balloon was built, and after a trial in calm weather appeared to be attended with considerable success. The action on the part of the French certainly had the effect of stimulating other countries to activity in the direction of military aerostation, particularly Russia and Italy.

An interesting machine was that invented by Frederick Brearey in 1879. It consisted of an elongated body, bearing in shape about the same relation to an ordinary balloon that a needle bears to an egg. It was sharply pointed at both ends and intended to contain the necessary machinery and the passengers. On either side extended flexible lever arms of huge size, while a flexible spar extended from the tail end of the body. Silk or other suitable fabric is extended from the arms and along the spar, thus giving a large supporting surface. Vibrations were to be imparted to the arms, which would propel the machine by a wave-like motion. But the inventor had not provided for the generating power, and doubtless awaited the improvements in electricity. Before his death a few years ago, Brearey was responsible for various other aeronautical contrivances ; he was an enlightened student of the subject, and long held the post of Secretary of the Aeronautical Society, which is now held by Mr. Eric Stuart Bruce.

The propulsion of a loose, undulating surface was first suggested to this inventor, as he tells us, by the movements of a skate fish in an aquarium. In swimming it undulated its whole body, and this principle, applied to propulsion in air, added greatly to the stability of the flying device. Mr. Brearey's invention may be regarded as a kind of dirigible parachute, which would descend safely if the motive power became exhausted from any cause. From his experience with machine models, having 16 square feet of surface, Mr. Brearey was enabled to state in 1882 that "The power requisite to propel and sustain a body in the air has been greatly over-estimated, in view of the ultimate attainment of flight."

It was early found that india-rubber furnishes a good reservoir of power to experiment with. It is true the flights are brief, as the power is soon spent, but they give an opportunity of testing the equilibrium, the proportions and the adjustment of the parts, which may suggest themselves to an experimenter as possibly efficient.* Consequently, numerous flying-machine inventors have availed themselves of twisted india-rubber for their models, among the latest being Professor Langley, Barnett, the American aviator, and Mr. Brearey in England. It is also the motive power of the toy screw of M. Dandrieux, which can be purchased at any large toy shop, and gives a very good idea of a true aeroplane.

It was in this year that William Lloyd Wise brought

* Octave Chanute, C.E.

forth his aeroplane balloon, which attracted considerable attention. It was dart-shaped and formed of a double skin to receive gas. By heating an expansion chamber the entire machine was made to displace more air than its entire weight, and thus possess a lifting power. The centre of gravity was adjusted by means of a movable weight, and the angle of the aeroplane could thus be adjusted and cause the ascending or descending force to propel the machine forward.

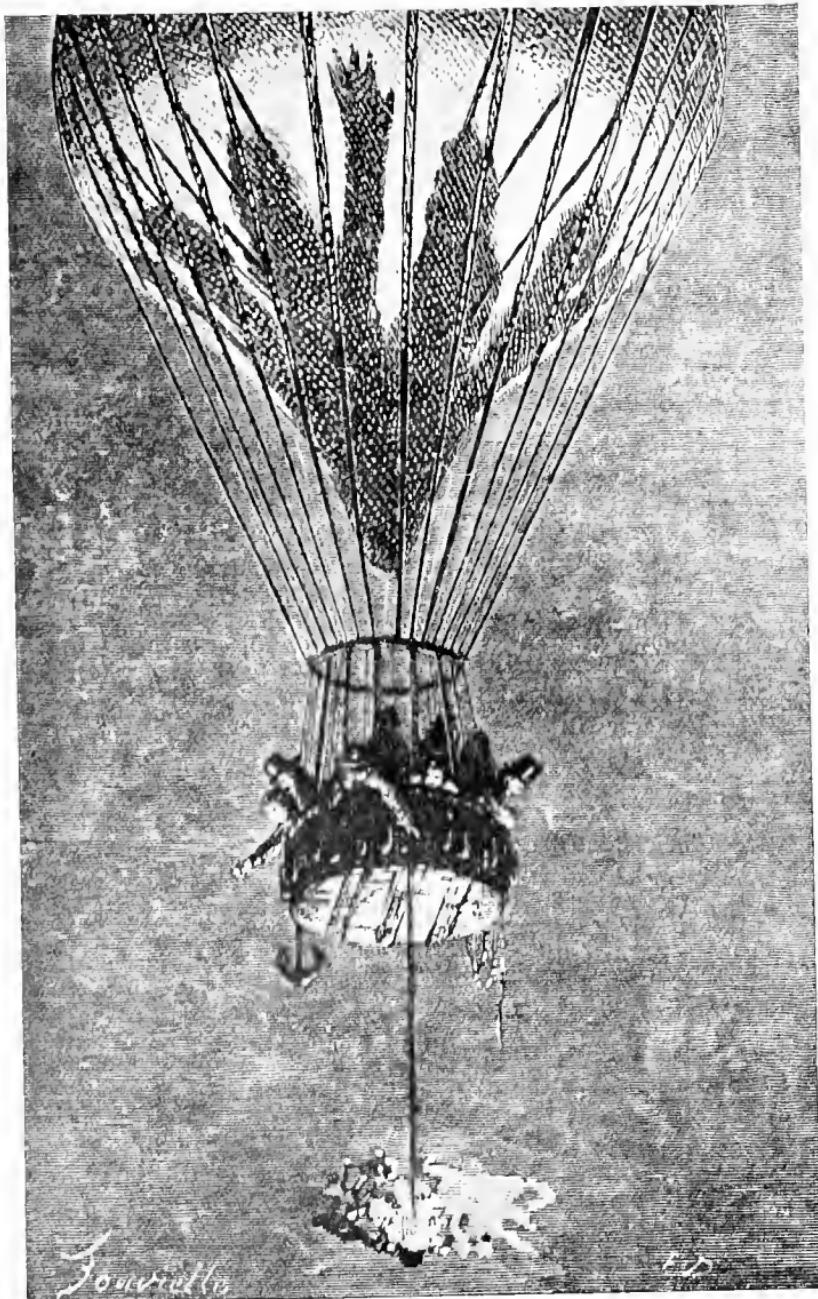
In 1880 English military ballooning, whose slow rise and progress we have recorded in preceding pages, received a sudden check by the loss of the Government balloon, the "Saladin," which disappeared with Mr. Walter Powell, M.P.

Mr. Powell, who represented Malmesbury in the House of Commons, was an enthusiastic aeronaut. He had made several ascents, having had a private balloon constructed for his especial use, with gas-works from which to fill it. In aeronautical circles he enjoyed a reputation for his experience, skill and courage. About noon on Saturday, 10th December, 1881, he ascended in a War Office balloon, "Saladin," in company with Captain Templer of the Rifle Corps and Mr. Agg-Gardner of Cheltenham. The object of the trip was to take meteorological observations. It was pointed out that when the days were so short it is extremely hazardous to risk a balloon ascent so late as noon, especially when there is a current of wind capable of carrying the balloon along at the rate of 35 miles an hour.

It appears that the balloon kept on in a direct line to Exeter, where it would have been prudent to descend. However, a contrary wind was then at the disposition of the aeronauts, and this they permitted to carry them back to Bridport. Finding at this point that there was some danger of their being carried out to sea, a hurried attempt was made to descend. But this, in a stiff breeze, was not found an easy feat. At length the car touched the ground and began dragging, and, while in this state, Captain Templer and Mr. Gardner succeeded in getting out, the latter at the cost of a broken leg. The balloon thus lightened then rose and was driven out to sea, carrying Mr. Powell with it. He was never seen or heard of again, although the balloon was thought to have been sighted in France and Spain. It is believed that the rapidity of the ascent caused such an escape of gas as would suffice to asphyxiate the unhappy aeronaut in any case.

Nevertheless, the Balloon Corps at Aldershot grew in popular favour, and Lord Wolseley, on making his first balloon ascent at Lidsing, near Chatham, declared that "had he been able to employ balloons in the earlier stages of the Soudan campaign, the affair would not have lasted as many months as it did years."

The year that was marked by poor Powell's disappearance witnessed a great activity in the ballooning world, numerous patents having been taken out in England and France for navigable balloons of every



NIGHT ASCENT OF EUGENE GODARD.

description. It is impracticable and would be fruitless of interest to mention here all these devices. That of Mr. Blackman, consisting of a cigar-shaped aerostat with propelling screws at each side and a steering-screw fore or aft, was typical of many others.

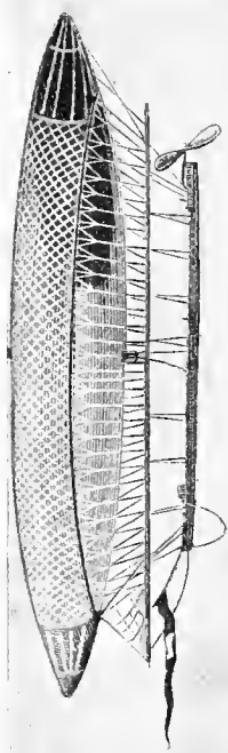
It was in 1880 that the celebrated inventor, Edison, turned his attention for a brief period to aerial navigation. He began his preliminary experiments by seeking to ascertain the exact value of the aerial screw as a propeller. For this purpose he is said to have placed a 10 horse-power electric motor in connection with a vertical shaft surmounted with rotating vanes upon a platform scale, his object being to ascertain how much the whole could be lightened by the action of the vanes upon the air. Upon the shaft was rigged first one kind of propeller and then another, with varying success, the best being a two-winged fan with long arms. The result obtained was to lighten the apparatus, weighing 160 lbs. only some four or five pounds. This induced the great inventor, whose experience was much less fortunate than that of others, to throw up the project in disgust, with the remark that "the thing never will be done until an engine of 50 horse-power can be devised to weigh about 40 lbs."

Besides the steam-balloon invention of Captain Pherekyde, a Russian officer, M. Kostovits, constructed a gigantic aerostat, whose size, he claimed, rendered it more dirigible and also faster. This machine, 230 feet long, was found to sustain a car capable of holding sixteen passengers and a considerable supply of ballast. The

inventor also laid claim to the discovery of an apparatus capable of furnishing 300 cubic metres of hydrogen in eight minutes, which would suffice to inflate a small captive war balloon held by a rope 300 metres in length. The purpose of the balloon was to carry a powerful electrical light by which to convey signals on the plan of the Morse code.

In Italy a machine similar to Giffard's was invented by Sr. Pietro Cordenons, to which he gave the title of "aeronave." It had a screw fixed in the stern of the aerostat, and a triangular rudder attached to the car. The motor of this screw was a steam-boiler, enclosing liquified ammoniac gas, which, after having acted on the two sides of the pistons, came to dissolve and furnished fuel to feed the engine. But the invention, ingenious as it was, was not found practicable, as applied to a dirigible balloon.

The 9th August, 1884, deserves to be memorable in the annals of aerostation, because on that day MM. Renard and Krebs accomplished for the first time a balloon voyage in a circle, returning to the point of departure. Captain Renard was the officer in charge of the official balloon establishment at Chalais-Meudon, while his associate was an infantry officer greatly interested in aeronautical science. For some years previous the pair had been making experiments with a cigar-shaped balloon, furnished with a screw propelled by electricity and a rudder. On this occasion they actually succeeded in accomplishing the above feat, travelling a distance of seven kilos in twenty-three



KREBS AND RENARD'S DIRIGIBLE BALLOON.

minutes and descending at Meudon in safety. The balloon was constructed of great lightness and firmness, 150 feet long; the car was of bamboo, and the dynamo operating the screw was of eight-horse power.

The achievement was naturally hailed with great enthusiasm throughout France, and on the 28th October the experimenters renewed the attempt, making two ascents the same day, and each time returning to the point of departure. But it could not be concealed that the most favourable atmospheric conditions attended all the experiments of Krebs and Renard. Their balloon hung in a shed perpetually inflated, at Government expense, waiting for fine weather, and only when the latter was perfectly suitable did they venture upon a journey. Nevertheless, with their machine and its powerful battery, the constituents of which they would not reveal, they had made a great stride towards the problem they aimed to solve.

Any intelligent child who has flown a kite is aware experimentally that planes properly inclined, driven or dragged through still air, or held in currents of sufficient velocity, will rise, not only so, but they will raise and sustain weights proportioned to the flying machines we call kites. The deduction is that the same amount of force equally well applied would change the kite into a free flying machine, sustain it and move it through the still air at a rate equal to that of the wind which pulls the string. And it is because birds fly and because children fly kites that larger flying machines may be regarded as possible inven-

tions. Of course, in herewith glancing at the various attempts of this kind, we may observe that the main difficulty is to construct portable engines of sufficient power to propel planes with a velocity equal to overcoming the weight of the whole machine—steam-engines are still too heavy for their strength.

The idea of a char-volant, or man-supporting kite, is probably a very old one. In a work published about 1860, a special contrivance of the sort was minutely described, as being suitable for military purposes. Mr. Wenham, a few years later, also suggested that a form of kite should be used for reconnoitring and exploring, in lieu of balloons held by ropes.

One of this kind was invented in 1875 by A. M. Clark. The "kite for suspending a person in the air for military purposes" might be provided with a frame, and held in tension from the ground by three or more ropes instead of a single one, as had hitherto been the case.

Another kite, devised by Joseph Simmons the same year, was composed of a fabric strengthened by means of a net and stretched on a framework. It was employed for raising a car containing an aeronaut. Should the rope break, the kite instantly performed the grateful functions of a parachute. A similar device was invented about the same time by Josiah Snow.

In July, 1880, M. Biot patented and exhibited an ingenious kite, which sailed without a tail, and possessed great stability in all conditions of wind. Biot, who had long experimented with kites, having,

as far back as 1868, been lifted from the ground by a large apparatus of this kind, found his model's work so satisfactory that, in conjunction with M. Dandrieux, he designed a full-sized aeroplane, capable of carrying a man. It was not, however, till 1887 that his soaring apparatus, in the shape of an artificial bird, 27 feet across and weighing 55 lbs., was actually tried. On one occasion Biot suffered a severe fall, which put an end to his experiments.

Kites for a time engaged most of the aeronautical talent of the day. Amongst the more notable experimenters was Maillot, a French rope-maker, who, in 1887, succeeded in sustaining in the air a weight of 594 lbs., or the weight of four average men. Other trials were made by Jobert, Copie, Boynton and Bazin, the inventor of the "bi-polar" kite.

The majority of all the inventors and experimenters of aeroplanes have proposed some species of motive power, only to find their designs stultified, as Edison's was, by the lack of a sufficiently light motor.

In 1888 an Australian, Mr. L. Hargrave, showed the possibilities as regards extreme lightness and power of a motor for a flying machine. It took the form of a compressed air engine, weighing only two pounds seven ounces, cylinder $1\frac{5}{8}$ inch diameter, stroke 2 inches. The receiver for the compressed air was 0.21 cubic feet capacity, made of $\frac{1}{16}$ inch steel, single riveted and brazed. The bursting pressure was 900 lbs., working pressure 500 lbs., and reduced pressure 900 lbs. per square inch. There would be

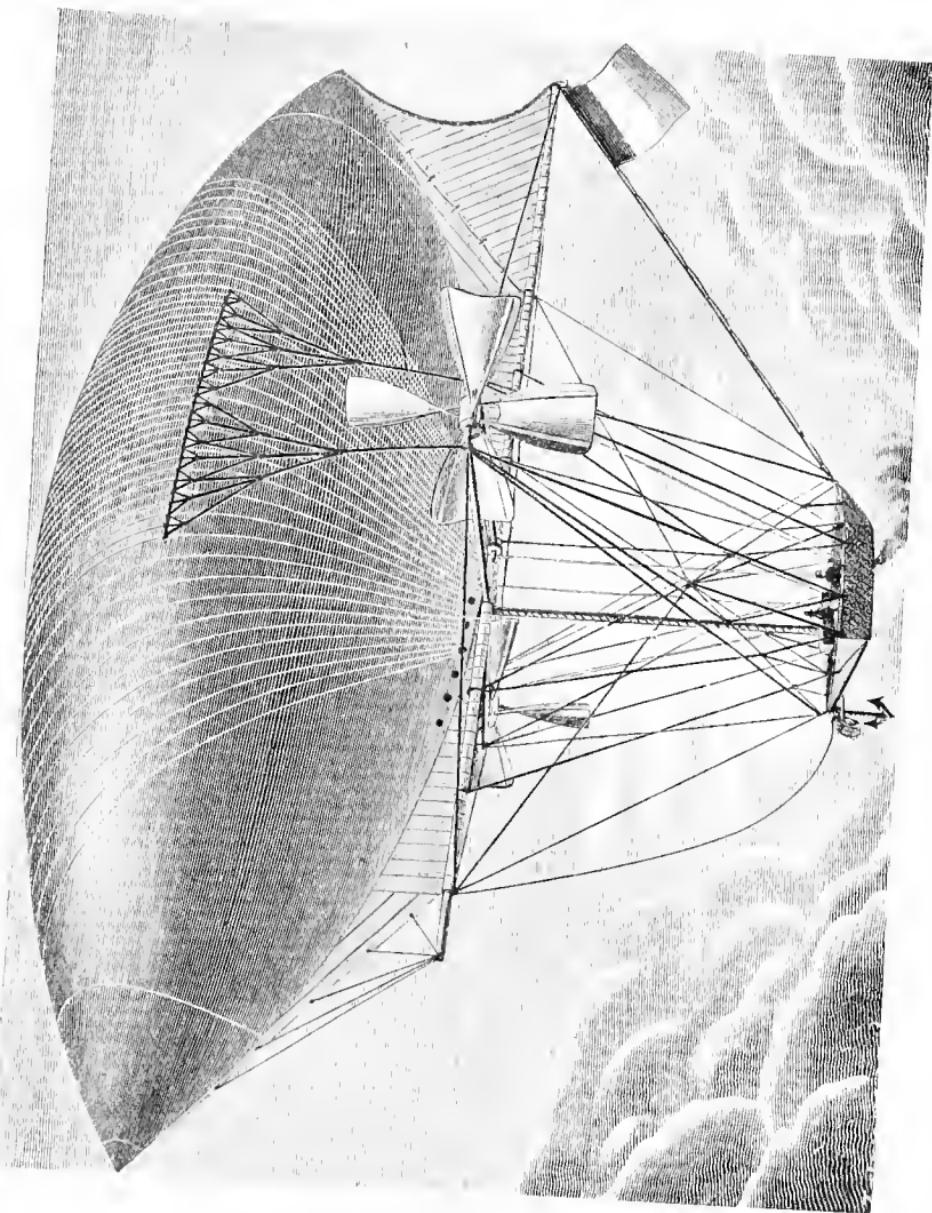
9,200 foot pounds available for work; which power would have to be expended in from half to three-quarters of a minute. The charged receiver weighed 6 pounds 12 ounces. The machine was intended for a flight of 200 yards.

Hargrave had constructed no less than eighteen flying machines of various sizes, and was sanguine of ultimately attaining success. He took out no patents for any of his aerial inventions, and indeed published from time to time full accounts of them in order that a mutual interchange of ideas might take place with other inventors in the same field. From his exhaustive labours much advantage has certainly been reaped.

A curious type is the navigable balloon of Wolf Gustafson, consisting of an elongated balloon, supporting a framework. Beneath is a propeller worked by an aeronaut very much in the manner of a cyclist.

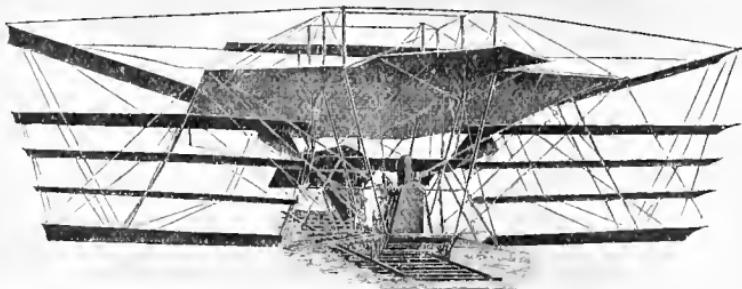
The principle of jet propulsion was utilised on an important scale in the invention of Mr. G. S. Parkinson in 1888. Three great jets of air were ejected from trumpet-shaped mouths situated at the stern and on either side of the balloon. This air was forced through the mouths by means of a fan or blower worked by the aeronaut or by steam or electricity.

In the navigable balloon of Rieckert three compartments are provided for, situated one above the other, the lower compartment being strengthened by



GABRIEL YON'S STEAM AIR-SHIP.

a wooden frame-work. The second compartment is attached to the upper surface of the lower one and the third compartment is situated above the second, shifting its position according to the direction of the wind. A fan or propeller is driven by treadle mechanism, and the passengers are provided with seats within a closed car. Four boats are carried below the car for supporting the apparatus should a descent be made on water.



MAXIM'S FLYING MACHINE.

Otto, the inventor of the bicycle long bearing his name, sought to apply the principle of his invention to aeronautical propulsion. His experiments in 1889 aroused considerable interest, which however, were eclipsed by the invention of Mr. Hiram S. Maxim. This celebrated inventor had long devoted his time and talents to the subject of aerial locomotion. He stated that in the present instance, his aim was to construct a flying machine having great power, effectually expended. Every part of his machine

was to be constructed as lightly as possible consistent with the requisite strength. It comprised, to begin with, an aeroplane, constructed with steel tubes covered with fabric, pivoted to the main frame in such a manner that it might be adjusted up or down, to any required angle. Two propellers, constructed of spokes covered with silk, were mounted on the frame below the aeroplane, and by driving these propellers at varying speeds, the machine might be steered to the right or left. The propellers were driven by separate engines, supplied with steam from a boiler composed of comparatively large tubes connected by tubes of very small diameter, thus giving a considerable heating surface. The heating of this boiler was to be effected by the combustion of vaporised hydro-carbon. By means of a condenser the necessity for carrying a large quantity of water was obviated. The machine was to be started on rails, one pair of these being below the wheels and another pair a short distance above them. By running the machine along and observing the angle of contact with either set of rails, the required inclination of the aeroplane would thus be ascertained before the apparatus rose in the air.

A trial of this machine led Mr. Maxim to make further improvements and so, two years later, to a new invention, which we will describe in its place.

We have already noticed the long voyage in 1859 by John Wise. Twenty-eight years later a balloon, constructed by the *World* newspaper, left St. Louis.



SANTOS DUMONT'S DIRIGIBLE BALLOON: A TRIUMPHAL ESCORT.

for New York. It held 160,000 cubic feet of illuminating gas, and was in charge of Mr. Moore, who was accompanied by Professor Hazen, the meteorologist. Unfortunately, although 25,000 persons had assembled to witness a memorable event in the history of aerial navigation, the occasion was marked by a series of accidents from the moment of inflation. When a proper ascent was finally made, so much ballast had been expended that the voyage was abandoned at nightfall. The distance covered was barely 54 miles.

In the flying machine of William Cornelius, two wings were fulcrumed on the free ends of a **U**-shaped frame. A seat was provided within the frame for the aeronaut, while the wings were worked by handles attached to the inner ends of their rods. As in the case of the earliest flying man of modern times, Besnier, in 1672, the legs were not to be idle. A hinged tail of an inverted trough form was attached to the rear of the frame, and actuated by cords attached to the feet of the aeronaut.

Mr. Owen's flying machine of the following year was simpler, two propellers being mounted on vertical axes at the upper part of the framework and worked by treadles.

In the year 1889 Mr. Percival Spencer, the celebrated aeronaut, having undertaken to make a parachute descent from a balloon let loose on the Calcutta race-course, owing to a failure of gas the balloon would not rise. Mr. Spencer cut free the

parachute and the balloon shot up in the air without any apparatus for regulating its descent. It was soon lost to sight, and eventually, having reached an altitude of 13,000 feet, began to descend. Spencer at last alighted uninjured on a small island in the Sunderbunds, about 40 miles from Barasut.

And now we are constrained to close this chapter with a series of accidents.

In 1887, after two unsuccessful attempts, Mr. Morton crossed the Channel in a balloon from Dover, and having travelled about 70 miles in five and a-half hours safely descended at Roon, a village 33 miles east of Calais.

In November of the same year, M. Mangot and M. L'Hoste, two well-known French aeronauts, were drowned in attempting to emulate Morton's feat. They were last seen about 39 miles south of the Isle of Wight, and were probably dashed into the sea by the violence of the storm of wind and rain which was raging at the time.

Mr. Simmons, the aeronaut who had made 495 ascents, while descending in a balloon near Witham, in Essex, in 1888, met with an accident which resulted fatally. He had, with two other gentlemen, ascended from the Olympia grounds at Kensington, at 4 p.m., August 27. An hour later, when attempting to descend for the night, the grappling-irons having firmly caught, the balloon suddenly burst when about 50 feet from the ground and became detached from the car, which fell heavily to the ground, and was crushed to

pieces. Simmons alone was fatally injured, one of the others escaping with a broken leg, and his companion without serious harm.

The year was not yet done with fatalities. In November an American aeronaut named Vandegrift having ascended from Columbus, Ohio, to a height of about half-a-mile, the balloon burst. With great presence of mind the aeronaut cut the cord of the parachute and tried to get clear of the rapidly-falling balloon. After a few seconds the parachute was carried off by the wind and began to fall slowly, but unfortunately it fell on the swollen waters of the Chatahoochee river, and despite all efforts of the bystanders, Vandegrift was swept away and lost.

At the Crystal Palace a balloon ascent was made in 1892 by Captain Dale, his son and two friends. On reaching an altitude of 600 feet, a large rent appeared in the silk, and the gas escaping, the car fell heavily to the ground, causing the almost immediate death of Captain Dale and seriously injuring the other occupants.

CHAPTER VIII.

IN spite of the researches of Borelli, of Wenham, Mouillard, and of Ader, notwithstanding even Professor Langley's demonstration, we do not yet know just how birds fly, and consequently cannot accurately imitate them. "It is a phenomenon," says Mr. Chanute, "going on daily under our eyes, not yet reduced to the sway of mathematical law." A long and vexed controversy has been maintained, not only about the power required, but about the principle or method in which support is derived. The old idea was that when large birds flapped their wings downward they produced thereby a reacting air-pressure wholly equal to their weight, and so obtained their support. This became known as the "orthogonal" theory, and has been disproved by calculations of the velocity and resulting pressures of the wing beats of larger birds, and by the more recent labours of Professor Marey.

As a matter of fact large birds cannot practise orthogonal flight, but derive their support mainly, if not wholly, from the upward reaction of the normal air-pressure due to their speed.

They are thus living aeroplanes, and under their

inclined wings their velocity creates a pressure which is normal to the surface, a theory which is confirmed by the great difficulty they experience in getting under way.

They run against the wind before springing into the air, or else drop down from a perch in order to gain the requisite velocity.

There have been numerous keen observers of the flight of soaring birds, whose theory has been that once under-way in a sufficient breeze, the performance involves no muscular movement whatever, save in balancing, and that the wind alone furnishes sufficient motive power, when blowing 10 to 30 miles an hour, to enable man to soar and "to translate himself at will in any direction, even against the wind itself."

A modern observer of this sort was M. Mouillard, of Cairo, Egypt, who devoted thirty years of his life in watching the soaring of tropical birds. He published in 1881 a very curious and learned treatise, "*L'Empire de l'Air*," on this subject, and also therein describes several attempts made by himself to initiate artificially this flight.

"I hold," says he, "that in the flight of soaring birds (such as the eagle and vulture) ascension is produced by the skilful use of the force of the wind and the steering in any direction is the result of skilful manœuvres; so that by a moderate wind a man can, with an aeroplane, unprovided with any motor whatever, rise up into the air and direct himself at will, even against the wind itself."

It is now, within the last few years generally admitted that a soaring bird can sustain himself indefinitely on a wind without flapping, and that man may learn to imitate him if only a proper apparatus be designed and the operator possess the necessary knowledge and skill.

An American philosopher, of the name of Lancaster, had the courage and the zeal for aviation in 1876, to exile himself for five years to a desert part of Florida, for the purpose of observing the movements of the great soaring birds. On his return he made a number of interesting experiments with, on the whole, useful results.

As long ago as 1872 M. Clement Ader, of Paris, constructed his first huge artificial bird, and thereafter devoted his life to aviation. Moved by the accounts of the sailing of large birds given to the world by M. Mouillard, who, as we have seen, witnessed them in Africa, M. Ader first obtained from the Zoological Gardens some eagles and also some large bats, and carefully observed their flight in his workshop. But regarding this as insufficient, he himself went to Algeria. Being unable to find any of the large vultures near Constantine, he disguised himself as an Arab, penetrated into the interior with two Arab guides, and by enticing the birds with pieces of meat, left in secluded places, succeeded in obtaining ample facilities for observation.

M. Ader stated that he was fully convinced after this that these huge vultures, measuring 10 ft. across, do

not beat their wings when rising in the air. They flap them two or three times at first, and then hold them rigidly spread out to the current of the wind, upon which they ride, and upon which they rise in great circling sweeps by merely adjusting their aeroplane to the varying conditions of the wind.

When Ader, therefore, next built an artificial bird, he was admirably equipped with knowledge. He had already spent more than £25,000 in his aerial experiments. The machine was hidden for many months from the gaze of the curious, and all Paris became agog to know the issue of the experiments. At last, during the summer of 1891, it was said that a well-known artist, while hunting in the suburbs, caught a glimpse through the leaves of a strange object resembling an enormous bird of bluish hue. It was impossible to approach close to it; an enclosure surrounded the private park of the banker, Pereire, where the machine was situated. A sketch was made of the machine and published in "*L'Illustration*," where it caused a great sensation. It is forthwith announced that Ader's bird, the fruit of twenty years of study, had actually succeeded in rising to a height of sixty feet and in flying a distance of some three hundred yards.

The bird was fifty-four feet across, and was actuated by a motor propelling screw. The inventor stated his satisfaction at the trials, and narrated his opinion that it was destined to play an important part in the national defence of his country.

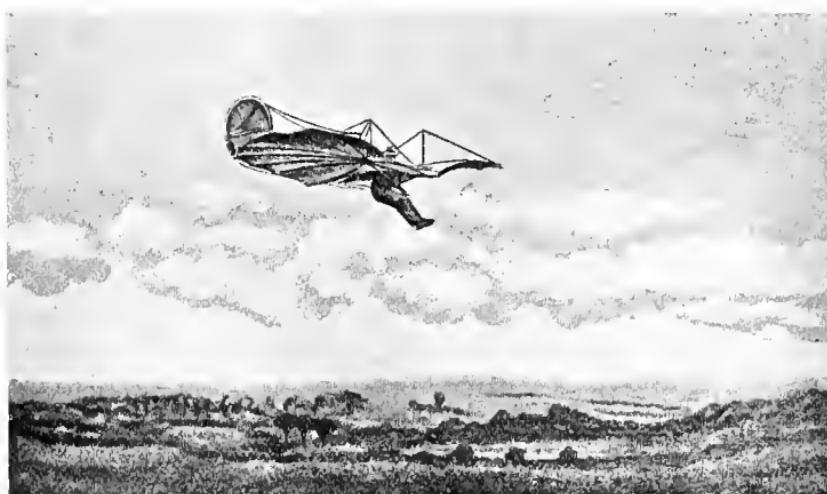
But perhaps the most careful and thorough series of

experiments in aerial flight that have ever been made were those of Otto Lilienthal, of Berlin. Lilienthal maintained at the outset of his trials that the real cause of the superiority of birds was their dexterity alone. After years spent in observation he published in 1889 a book on "Bird-flight as the Basis of the Flying Art," in which he gave the result of his investigations.

The German Professor, Helmholtz, who has carefully investigated the subject of the flight of birds in its relation to aeronautics, has announced his opinion that owing to the conditions of weight and strength, man would never be able to fly by his own power. But this theory was combatted by a fellow-countryman, Otto Lilienthal, who, not content with pronouncing his opposition, gave a practical illustration of his own beliefs, and eventually sacrificed his life to the cause of aerostation.

In the course of this record of the achievements by individuals in the art of flying, we have often had occasion to mention "flying men," who were sustained by wings on the bird or bat principle, and worked by themselves. But none of these ingenious experiments have ever attained the success of Lilienthal, who really managed to sustain himself in the air, and, according to the best authorities, only required practice in the art of soaring to enable him to solve the problem of aerial flight. As a starting point Lilienthal had chosen the study of the flight of birds, which may be divided into three distinct kinds, flapping, steering and soaring. Of these, the one demanding the least expenditure of

energy is soaring, and investigation showed that "under certain conditions flight is possible, if the wind possesses a vertical component. Experiments showed that surfaces can acquire a horizontal motion by the action of the wind only, when their curvature bears a certain relation to their superficies, and that this relation



LILIENTHAL AND HIS FLYING MACHINE.

corresponds exactly with that which is observed in the wings of birds.*

Lilienthal's flying machine consisted of a correctly curved surface, whose area was about fourteen square yards, made by stretching linen over a light wooden frame. Its weight was about forty pounds. In the centre was an aperture for the experimenter's body, and the apparatus was held in position by his arms. On running rapidly down a gentle slope of a hill

* Dr. A. du Bois Raymond.

against the wind the latter soon acquires a vertical component, which then carries the flying apparatus, and propels it in a direction against the wind. In his experiments in 1893 Lilienthal had sailed over a space of over one hundred yards at an altitude of 75 ft. in one minute ; in a favourable wind he had covered four hundred yards.

Lilienthal's investigations in aerial navigation were conspicuous from all other contemporary attempts by the great difference in the method adopted. The principle of most flying machines is an apparatus which will be self-navigating. Lilienthal reverted to the primitive type, in the ante-balloon epoch, but with the results of science super-added. The whole success of aerial flight may be summed up in the word *Equilibrium*. Lilienthal depended upon his powers of *instinct* to maintain his equilibrium. Man, in his case, was the main flyer, the apparatus being only the adjunct. He held that falls were to be expected in the preliminary trials, until the operator became accustomed to the many new conditions which make themselves apparent at every step. There is no form of auto-locomotion in which such difficulties have not to be contended with, as in bicycling or skating. To carry out his experiments the inventor threw up in the neighbourhood of Berlin a large conical mound, 15 metres in height, which he utilized as a starting point for his flights. With a tight grip of the frame-work with his hands he runs quickly down the slope until he has attained sufficient velocity to raise him and his apparatus off

the ground. When such condition had been obtained he sailed off until he alights again on the earth. To come down easily and safely, he applied the brake, by offering to the air a greater expanse of wing, whereby his velocity was instantly reduced.

In a further developement of his invention, the extremities of the wings were composed of a series of feather-like sails. These latter were connected with a small machine near the operator's body, which was driven by carbonic acid gas, and set in motion by a simple pressure of the finger. Such an addition, of course, increased very considerably the weight, therefore the difficulty of handling the apparatus. Consequently, Lilienthal proposed to use it only when the conditions were most suitable.

In 1896, Lilienthal made further improvements in his machine. His experiments had now attracted the attention of the whole of scientific Europe, and he already had disciples in England, France and America. His ambition now was to practise in such strong winds as to be able to be borne along with them. For a considerable time he had practised in moderately rough weather, and was often obliged to perform fantastic feats in the air to keep his equilibrium. But he was fortunate in nearly always obtaining a safe landing. His new idea was the substituting for one large framework, of two smaller ones, placed parallel one above the other, and thereby obtained the most interesting results. With a wind velocity of 18 feet a second, the sailing surface of 18 square metres carried him in a

nearly horizontal direction from the top of a hill against the wind, without his having to run at the start. Sometimes in his flights he found himself in the air, at a standstill, at a higher altitude than he was at his starting point.

“At these times,” he said, “I feel very certain that if I leaned a little to one side, and so described a circle, and further partook of the motion of the lifting air around me, I should sustain my position. The wind itself tends to direct this motion; but then it must be remembered that my chief object in the air is to overcome this tendency of turning to the left or right, because I know that behind or under me lies the hill from which I have started, and with which I would come in rough contact if I allowed myself to attempt this circle sailing. I have, however, made up my mind, by means of either a stronger wind or by flapping the wings, to get higher up and further away from the hills, so that sailing round in circles, I can follow the strong up-lifting currents and have sufficient air-space under and around me to complete with safety a circle, and lastly, to come up against the wind again to land.”

But, alas, the daring inventor’s ambition was not to be realised. What had been predicted by some of those who had watched him, came to pass during the summer of 1896. On August 11th, he started from the village of Rhinow, in the province of Bradenburg, and had flown along safely for about 200 yards, when a gust of wind suddenly caught and carried him

upwards. He thus lost control over the wings, and fell to the ground, broke his spine, and died soon afterwards.

By this tragic accident, science was robbed of a truly great experimenter in aerial navigation.

A similar machine to Lilienthal's was tried, with fair results, by the ill-fated Mr. Percy Pilcher, and by others ; but the problem is only to be solved by



[From a Photograph.]

LILIENTHAL IN FLIGHT.

years of patient practice, such as would be devoted to any feat of acrobatic skill, and this it has lacked. Lilienthal was the first to demonstrate that man can fly, but that flying must be the result of hard work. It is somewhat singular that professional gymnasts and acrobats have not attempted to follow up his invention within a padded or sawdust area, or over a body of water.

About the same time that Lilienthal was conducting his experiments, which were destined to have so fatal an end, another German, Gustav Koch, an aeronaut of Munich, obtained a grant from the Government to construct an aeroplane similar in character to his fellow-countryman's, except that the wings were rigid.

An American engineer, Mr. A. M. Wellington, observed in 1893 that if the conclusions so far reached by the advocates of muscular flight be accepted, "it is obvious that they greatly simplify the problem of artificial flight by reducing to a minimum the demand for power, making it chiefly necessary for acquiring the initial velocity." All attempts at aviation which include any motor for propulsion are, in his view, erroneous, since they "not only neglect but destroy the action of the forces by which true flight may be and is attained."

The original idea of blades with curbed surfaces to deflect upwards in the air, while a vacuum is formed above, belongs to Mr. H. F. Phillips, who experimented with such a contrivance some years since. In 1890, he followed this up by a flying machine in which these convex blades were employed. A number of them were placed one above the other in a frame, while two or more of the frames were attached to the upper part of a body propelled by a steam or electrical apparatus.

In order to minimise danger at sea, Mr. Fryers, in 1891, invented a balloon in the form of a ring. In the event of a descent on the waves, the car would not be obstructed, but, covered with waterproof canvas, would float free of the aerostat surrounding it.

In 1890, Mr. E. P. Frost designed a steam-bird machine, with wings 30 feet from tip to tip, in exact imitation of those of the crow. The accompanying machine, including engine and boiler, weighed about 650 lbs. It was expected to carry in addition the weight of a man, but the inventor declared the maker of the engine failed in his contract to secure the necessary power, and the apparatus did not fly. A similar machine, invented by Mr. Middleton, was also tried this year, but the right wing broke at a critical moment and put an end to the experiment.

Another curious flying machine was invented, in 1890, by Mr. R. F. Moore. It was constructed in imitation of a bat, with a frame below for carrying the driving-power and the load. The wings, made of bamboo, covered with silk, were made to oscillate and given a rocking motion. A not less interesting feature was the means of propelling this machine by an electric current from lines on the ground, thus dispensing with the weight of batteries. But, of course, no great distance could thus be traversed.

It is said that there is only one sovereign who has ever been up in a balloon—Queen Christina of Spain. Ten or twelve years ago she happened to pass a field where some balloon experiments were in progress, and it immediately occurred to Her Majesty that she would like to experience the sensation of being up in mid-air. After despatching her equerry to make the necessary arrangements, the royal party ascended, and remained suspended in space for a considerable time.

In 1894, at the Aeronautical Congress, held in Chicago, much discussion was indulged in by aeronauts from several quarters of the globe. It was at this meeting that a suggestion was put forward by Professor Todd, of Amherst College, that in view of the great risk in experimenting with flying machines, criminals should be detailed for duty in the common cause of science and humanity. "A man," said he, "convicted of slaughtering his wife, for example, instead of being forced to edify a handful of curious onlookers with the ghastly spectacle of capital punishment, might be permitted first to receive the coaching of some expert in aerodromics, then, on the day set for public exhibition, if both machine and aviator go to smash, well and good—the criminal would have had to suffer death anyway, and the builder of the machine would feel compensated by the opportunity for testing his device. If this trial succeeded, the gain to the art of flight may be enormous, and the culprit will come down presumably frightened enough to choose a life of virtue for ever thereafter."

One might retort in the words of the first aeronaut, Pilatre de Rozier, when King Louis XVI. proposed a similar expedient : "Shall criminals enjoy the glory of being the first to fly in the air?"

Some elaborate experiments of a machine resembling Lilienthal's apparatus were conducted at Dune Park, Indiana, in the month following that inventor's death. Seventy-five flights were made in the course of ten days, without any accident happening to Messrs.

Chanute and Hering, the projectors. A distance of 300 feet was covered in the soaring machine, at a height of about 30 feet from the ground, with less jar and shock than a ride on a bicycle. Two men carried the apparatus up the sand-hill, the inventor adjusted himself under it, and the wind, raising the machine, darted it through the air at a great velocity. The motion was horizontal, without any swaying. To stop the machine the operator had only to tilt it slightly upwards in front, when it coasted gradually to the ground. Once in a strong wind, the aeroplane soared suddenly and unexpectedly, carrying aloft with it four men, who were holding the ropes, to the height of 100 feet. The combined weight of the quartette soon brought it down without accident, the performance of the machine in this emergency being especially gratifying to the inventor. Hering's apparatus was modelled after the general form of an albatross, but with seven wings. Another machine, by Mr. Paul, showed a variant of this model. When it was tried it dropped rapidly from a height of 65 feet, striking a clump of trees and falling to the ground. The inventor was stunned, but not seriously injured, as a penalty for constructing his machine of too heavy materials.

In 1896 an end was put to the long stagnation in scientific aeronautics in France by the bequest of £4,000 by M. Eugene Fariot, an aeronaut and engineer of some repute, who had more than a quarter of a century before escaped from Paris in one of the siege balloons. The money was bequeathed to the

Société Française de Navigation Aerienne, and was to be expended in experiments.

At the close of the previous year a bill was introduced into the American Senate to provide for the award of money prizes of \$100,000 and \$25,000, the first for the successful achievement of mechanical flight, and the second for improvement in soaring machines.

Early in 1895 Herr Salomon Andrée, the chief engineer of the Swedish Patent Office, publicly announced at Stockholm a stupendous project of his to travel to the North Pole in a balloon. To carry out his plans he required a sum of between £7,000 and £8,000. Andrée had already executed a number of very difficult ascents, and was, besides, well acquainted with the peculiarities of Arctic climates, having been one of the meteorologists of the Swedish Expedition (1882-83) for observing the transit of Venus from Cape Thorsden. It was from this station that he proposed to start July, 1896, as there are no great variations of temperature at that time of year.

A national subscription was soon opened, the King of Sweden contributing a large sum; the late Alfred Nobel alone subscribed £3,588. The financial outlay being thus assured, Andrée made a number of journeys to various European capitals in order to consult scientists and practical aeronauts upon his scheme, and the precise manner in which he should carry it out. The prime consideration was, of course, the balloon. As to this, Andrée's choice fell upon Chinese pongee silk, as prepared for balloons in France. In the con-



ANDRÉE'S EXPEDITION--COVERING THE BALLOON.

struction of the car the use of iron or steel was prohibited, in order not to interfere with the action of the magnetic instruments. It was therefore entirely of wood and wicker-work; a feature of the whole was that all the articles comprising the aeronautical equip-



ANDRÉE'S BALLOON—OFF AT LAST.

ment were marked with the words "Andrée's Polar Expedition, 1896." This legend was branded upon wooden articles, engraved on metal articles, and painted with a durable paint on the protecting cover, the envelope, the tarpaulin of the car, and the ballast bags.

Even the ropes were fitted with small plates so inscribed. A trial of the balloon took place in Paris in May, 1896, when it was declared by such experts as Tissandier, Colonel Renard and M. de Nordenfeld to be faultless.

The balloon was thereupon transported to Sweden, and later embarked for Spitzbergen, but owing to unfavourable winds Andrée was obliged to return, and the start of the balloon voyage was postponed until the following year. On May 18th, 1897, the expedition left Gothenburg on the gunboat *Svenskund*, ordered by the Swedish Government to convey them to Spitzbergen. The cargo steamer *Virgo* accompanied them with materials for repairing the balloon-house, with an apparatus for producing hydrogen and other necessaries. On July 11th, Andrée, with his companions, Strindberg and Fraenkel, got into the car. Exactly at 2.30 in the afternoon Andrée gave the signal to cut the ropes, and with the cry of "Helsa Gamla Sverige!" (Salute old Sweden!) the balloon now christened the "Eagle," sprang into the unknown. From Danoe Island to the North Pole is a distance of about 600 miles, and the same distance had to be traversed on the other side before terra firma could be reached. The risks to which the explorers exposed themselves are thus seen to have been very great, and the fears of their friends were fully justified. It was held to be almost impossible that the balloon would keep afloat long enough to permit the expedition to be terminated in

THE KITE BALLOON—MOMENT OF ASCENT.



safety, even though its capacity was further enlarged 300 metres (making 4,800 in all) before starting, and the silk greatly fortified by additional coats of varnish.

Soon after this departure, which evoked the deep interest of the whole civilised world, southerly to westerly winds began to prevail over Spitzbergen and the ice regions, and the balloon was therefore assumed to have proceeded towards Siberia.

“ You will not hear from us before three months,” Andrée had said, “ and one year, perhaps two years, may elapse before you hear from us, and you may one day be surprised by news of our arrival somewhere. And if not—if you never hear from us—others will follow in our wake until the unknown regions of the north have been surveyed.”

It was some weeks before an authentic pigeon message was received. It read :—

“ July 13th, 12.30 p.m., 822° N. lat., 15° 5' E. long. Good journey E. 10° S. All well on board. This is the third pigeon post.—ANDRÉE.”

Andrée therefore appears to have despatched three of his carrier pigeons in less than three days, and the balloon seems to have covered, during the period, a distance of scarcely 187½ miles.

From that day to the present no other trustworthy

tidings of this daring balloon project has come to hand. Various rumours are circulated from time to time, but all eventually prove baseless, and the fate of Andrée and his two companions has yet to be told to the world.

A remarkable ascent was made from Stassfurt, Prussia, by Dr. A. Berson in December, 1894. The balloon was inflated with 70,600 feet of hydrogen, and attained the height of 22,150 feet, when Dr. Berson began the artificial inhalation of oxygen with excellent results. At about 29,500 feet the balloon passed through a veil-like stratum of cirrus clouds ; these did not consist of ice crystals, but of perfectly-formed flakes of snow. About two and a half hours after starting, a height of about 31,500 feet was reached, the thermometer dropped to 54° and indicated only—11 in the sun's rays. At this height Dr. Berson, being alone, thought it prudent to descend. At 4,600 feet the highest temperature was recorded—namely, 43°, and between this point and the earth it fell to about 34°. The ascent occupied three hours, and the descent two hours and twenty minutes, the balloon having travelled 186 miles, in spite of the wind being almost calm on the surface of the earth. These observations were made at a greater altitude than such had ever before been made in the history of ballooning. In Glaisher's celebrated ascent of September 5th, 1862 (see page 177), the best actual observation was 29,000 feet. In this instance, however, the balloon ascent was supposed to be some 7,000 feet higher.



GERMAN MILITARY KITE-BALLOON.

An aeroplane, differing from Lilienthal's plan, in being wholly passive, is the "Air-car or Man-lifting Kite," with which Lieut. B. Baden-Powell proposed to displace the balloon for military purposes. The machine consists of four or five sails of a flattened hexagonal shape, connected one behind the other, to the ground line. From the latter is suspended a basket car, with a parachute spread out above in case of accident. The number of kites required to lift the car depends on the wind. Lieut. Baden-Powell tried his kites on several occasions, once during the meeting of the British Association at Ipswich, and though the result has in a few cases been disappointing, yet on the whole success has attended the experiments. As this officer remarks: "We have here a machine capable of lifting a man safely to a height, which has many advantages over a balloon. It is infinitely more portable, it is infinitely less costly. It requires no reserve supplies and is not precluded from ascending by much wind. It is practicably invulnerable, and it promises to be of use in many circumstances rendering a balloon impracticable." As the Army Balloon establishment costs £3,000 a year, and the inventor of the above kite believed he would save two-thirds of this amount, it was sought—but vainly—to bring the invention vigorously before the Government.

In 1890, M. de Graffigny, a French aeronaut and a well-known writer on the subject, had experimented with a kite-like aeroplane, which, however, resembled many others in its design and action. The inventor

strongly urged the kite principle generally, as the one most likely to lead to success in devising a flying-machine, and in acquiring the management of it in the air.

Many proposals have been made at various times and in various countries to utilise kites in life-saving, but none appear to have come into practical use. Such attempts perhaps suggested to Mr. Simmons, the English aeronaut, his experiments of 1876, of gliding downwards under such buoyant sails.

During 1897 numerous trials were begun in Germany of a so-called kite-balloon, the invention of Capt. Parseval of the German Army. The principal idea was to have not only an elongated balloon, but to so slope it that its under side would act on the principle of the kite. In order to keep the balloon tightly distended and thereby preserve its shape, a reservoir with a funnel-shaped mouth was added, into which the wind was to blow; the stronger the gale the greater the internal pressure in this pocket. A sort of rudder-like attachment, consisting of a smaller balloon, was attached behind, in order to keep the whole steadily facing the wind. The volume of the main balloon was about 18,000 cubic feet.

That kites are quite practicable for the purposes of ascent has been quite recently demonstrated by Lieut. Wise, of the American army, who made such an ascent in 1897. He used four kites (a modification of the Hargrave invention), weighing about 16 lbs. each. They were attached to a windlass running out a

manilla rope, while, by means of another rope, young Wise was drawn up, and remained for a considerable time at a height of about 42 feet, taking a careful reconnaissance of the surroundings through his field glass. The wind was blowing 15 miles an hour at the time, and the pull on the kites was about 400 pounds.

On the whole kites have a practical future in aerial navigation, and can hardly fail to be of great value in military operations.

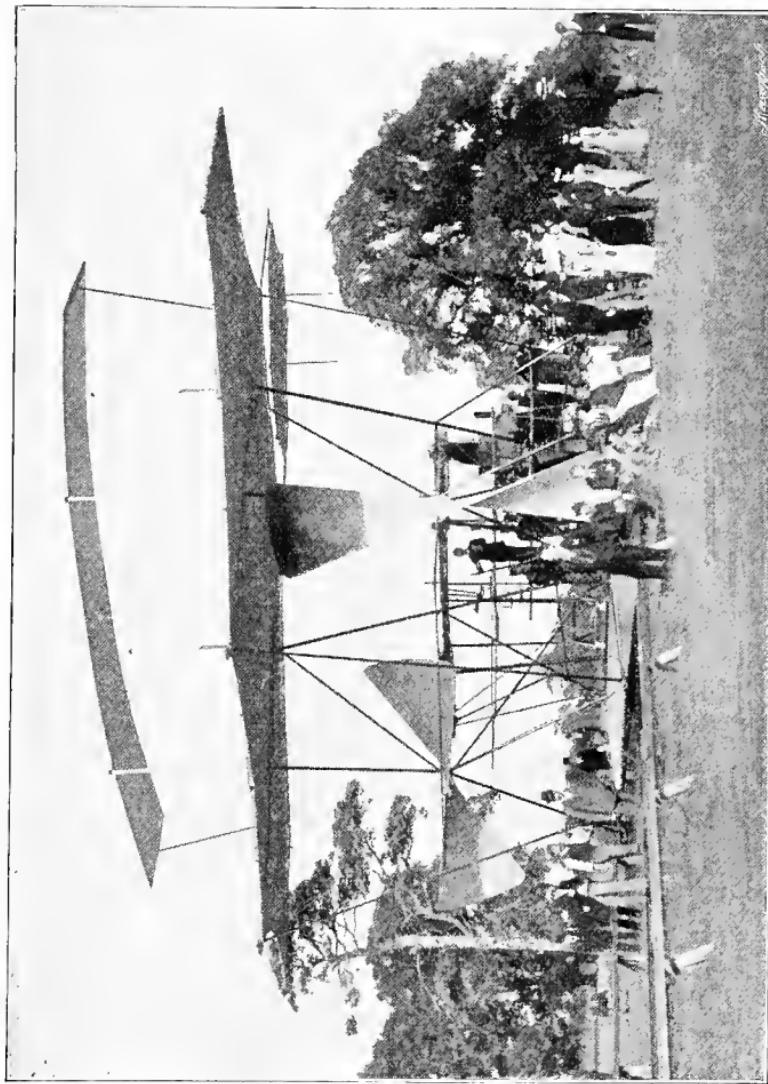
CHAPTER IX.

THE last decade of the nineteenth century was destined to be famous in the annals of aerial flight. Although many more flying machines were experimented with than in any previous period, yet repeated previous failures had apparently warned the inventors, and most of the trials—all the successful ones, with one exception—were made with models rather than with actual machines.

But on July 31st, 1894, for the first time in the history of aerial effort, or, indeed, in the history of the world, a flying-machine actually left the ground, fully equipped with engines, boiler, fuel, water, and a crew of three persons.

It is true it did not remain up long; but the fact that it rose into the air, actually tearing itself free from the guides placed to limit its flight, and only fell to earth when its sails became entangled, attested its success.

The inventor was Mr. (afterwards Sir) Hiram Maxim, and the machine with which he accomplished this feat weighed nearly 8,000 lbs. The actual force developed in the screws was 363 horse-power, with a



SIR HIRAM MAXIM GIVING HIS FRIENDS A TRIP ON HIS FLYING MACHINE IN BALDWYN'S PARK.

screw-thrust of rather more than 2,000 lbs. The total width of the machine was over 200 feet. It was found, upon setting it in motion at 30 miles an hour, very little load remained on the lower track, while at 36 miles an hour the whole machine was completely lifted.

Maxim's experiment proved that a flying-machine, carrying its own engine, fuel and passengers, can be made powerful and light enough to lift itself in the air. The experiments also showed that an aeroplane will lift a great deal more than a balloon of the same weight; also that it may be drawn through the air at a very high velocity, with an expenditure of power very much less than that required to drive a balloon at even a moderate rate.

Sir Hiram Maxim clearly proved that a well-made screw-propeller obtains sufficient grip on the air to propel a machine at almost any speed, and that the greater the speed the higher the efficiency of the screw. Such results as these certainly have advanced the problem of aerial navigation much nearer solution.

Lord Kelvin declared that this inventor had solved by his airship three out of the five divisions of that great problem. The two remaining ones had already been solved by Otto Lilienthal with his flying apparatus.

In any case, the name of Sir Hiram Maxim must ever stand amongst those who have done most to advance the solution of the problem of aviation.

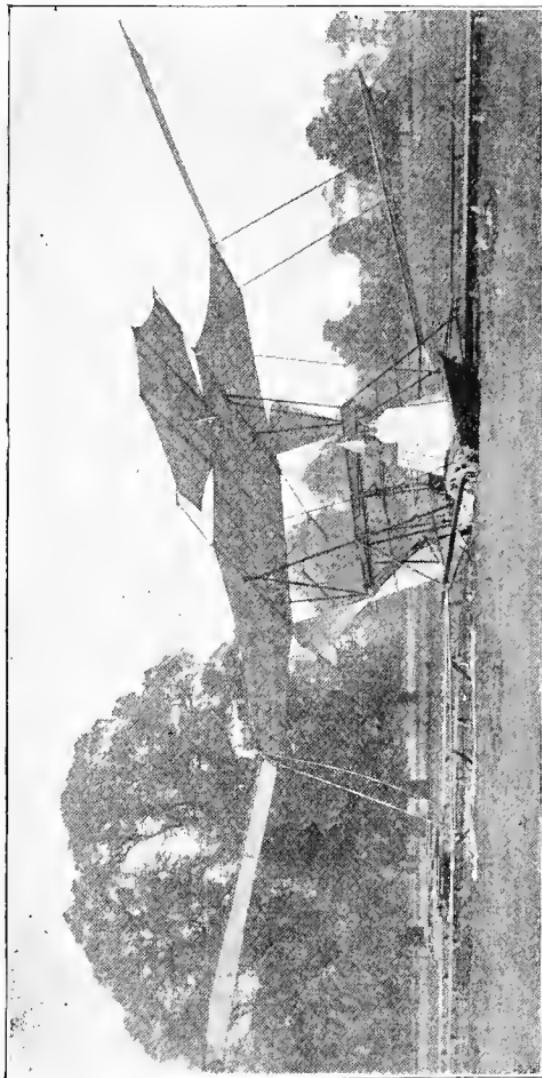
He himself says :

“ Propulsion and lifting are solved : the rest is a mere matter of time. Haste in such a venture is the worst of policies. Weak points must be thoroughly sought for, and everything made completely safe before the public is invited to consider the airship as a practical means of transit.”

The second great event in aviation happened two years later.

In the spring of 1896 it became rumoured that Professor S. P. Langley, of the Smithsonian Institute, Washington, who had been sedulously experimenting in the domain of aeronautics for many years, had actually achieved flight with his “aerodrome.” This machine was chiefly built of steel, and was not supported by any gas or by any means but its steam engine, which was of between one or two horse-power, weighing—including fire-grate, boilers, and every moving part—less than seven pounds. This engine was employed in turning aerial propellers, which move the aerodrome forward, so that it is sustained by the reaction of the air beneath its supporting surfaces. The total weight of the machine was about 25 pounds, and the length from tip to tip of the supporting surfaces was about 14 feet.

The public curiosity, which had been widely aroused by the first scanty reports, was at length gratified by one of the spectators of a memorable experiment on May 6th of that year, Mr. Graham Bell, the inventor of the telephone. It appeared that on



[From a Photograph.]

VIEW OF THE MAXIM FLYING MACHINE, AFTER ITS FAMOUS ASCENT OR FLIGHT OF THE 31ST OF JULY, SHOWING THE FULL ARRANGEMENT AND EXTENT OF THE AEROPLANES (LIFTING SURFACES), WHICH MEASURED 126FT. ACROSS THE WINGS; TOTAL AREA, 4,000 SQ. FT.; ANGLE OF PLANES, 72DEG. THE STEERING PLANES ARE SHOWN FORE AND AFT.

that date two actual ascensions were made, in such a manner that no one could "fail to recognize that the practicability of mechanical flight had been demonstrated."

"The aerodrome at a given signal started from a platform about 20 feet above the water and rose at first directly in the face of the wind, moving at all times with remarkable steadiness, and subsequently swinging around in large curves of perhaps a hundred yards in diameter and continually ascending until its steam was exhausted, when at the lapse of about a minute and a half and at a height which I judged to be between 80 and 100 feet in the air, the wheels ceased turning, and the machine, deprived of the aid of its propeller, to my surprise did not fall, but settled down so softly and gently that it touched the water without the least shock and was in fact immediately ready for another trial."

The second trial closely resembled the first, save in respect of the direction taken by the machine. The ascent was again made against the wind, continuing steadily in large curves accompanied with a rising motion and a lateral advance. So steady was its motion that a glass of water on its surface would have remained unspilled. As soon as the steam was exhausted it settled down gently as before. The machine in motion suggested a huge bird. As to the height attained by Professor Langley's machine, it was not less than 100 feet, having travelled about a thousand yards. "I had occasion," remarks Mr. Bell,

“to notice that its course took it over a wooded promontory, and I was relieved of some apprehension in seeing that it was already so high as to pass the tree tops by 20 or 30 feet.” The velocity was between 20 and 25 miles an hour.

It is hardly necessary to add that this achievement was heralded throughout the world with enthusiasm.

“I have brought to a close,” wrote Professor Langley, “the portion of the work which seemed to be specially mine—the demonstration of the practicability of mechanical flight; and for the next stage, which is the commercial and practical development of the idea, it is probable that the world may look to others. The world indeed will be supine if it does not realise that a new possibility has come to it, and that the great universal highway overhead is now soon to be opened.”

In the following year, in emulation of Professor Langley, experiments with a heavier steam aerodrome, of their own construction, were made by M. Tatin and Dr. Richet, in France, although not with equal success.

Yet, singular to relate, very little indeed has been done in this direction: the world seems to have gone back, after experiments in aluminium, to the simple aerostat filled with gas.

It was to be expected that the extraordinary qualities of lightness possessed by aluminium would cause a revival of the attempt made by Marey Monge in 1842 to construct a metal balloon. As soon, there-



THE ALUMINIUM AIR-SHIP IN MID-AIR,



fore, as aluminium grew cheaper several such air-ships were proposed ; but it was not until 1894 that Herr Schwarz began to build the first vessel of the kind, and it was to end in disaster on its completion in 1897.

The construction was undertaken under the auspices of the German Government ; the work was interrupted by the death of the inventor ; but his widow, who was in full possession of her husband's plans, obtained permission to complete it. The dimensions were fairly large, the aerostat being 134 feet long, and 46 feet high, and 42 feet wide, while the weight was about 5,720 lbs. It was operated by four screws, two for horizontal and two for vertical movement, worked by a benzine motor of about 10 to 12 horse power. The whole machine, apart from the driving belt and the brass bearing, was made of aluminium. Numerous devices for balancing, steering and descending, were, after the inventor's death, tampered with by the builders, and in some cases actually abolished, as adding superfluous weight. This, as was shown in the sequel, was a mistake.

"No one," it has been said, "except the inventor and his wife will ever know of the discouragements which marked the history of the Schwarz balloon, notwithstanding the help lent by the military savants of the German Government. The completion of the air-ship, however, and the final arrangements for a trial trip, threw discouragement into the shadow, and lent a rosy tint to the hopes of the inventor's wife. She was the only one who knew that the monster air-

ship with its silvery cylinder, would do the work for which it was intended, and it may be believed that the first two days of November, while the balloon was being filled, were to her, days of excitement and weary waiting for victory."

The first process in filling the vessel was to carefully expel all the air before the gas was injected, and this was done by a device of Schwarz's own invention.

A colossal silk bag, the size of the cylinder, was introduced into the cylinder, the hydrogen being slowly pumped into this receptacle. As the latter expanded, it gradually expelled the surrounding air from the cylinder, and once the air was driven out, the gas was permitted to escape into the machine proper.

The aerostat soon began to evince a marked tendency to rise, and when the filling was completed, tugged strongly at the ropes, thus confounding those critics who declared a metal balloon was impracticable and would never ascend. Herr Jaegels, the engineer in charge of the machine, although not an experienced aeronaut, volunteered to make the ascent, and took his seat in the car. It rose with great velocity to the height of 82 feet, moving against a strong wind. For a few moments all was in suspense, the juncture was a thrilling one. But, instead of going forward, the machine was seen to fall. It turned out afterwards that a single operator was insufficient for the purpose of working the apparatus. It needed more than one pair of hands. The driving belt slipped: had he operated the stern screw alone he would have been able to sail

THE ALUMINIUM AIR-SHIP: AFTER THE CATASTROPHE.



along with the wind as in an ordinary balloon. But his wits deserted the unlucky Jaegels : he threw open the valve and the balloon sped downwards. There was no device for regulating the descent, nor was there any apparatus for breaking the force of the fall. It seems as if Jaegel's life would be forfeited, but he jumped adroitly out of the car and landed almost uninjured. As for the Schwarz air ship it crashed to earth with great force and was instantly destroyed. After six minutes in the sky, the work of four years, which had cost £10,000, lay a shapeless mass on the ground.

Nevertheless, in spite of this mishap, it had been demonstrated that the principle of the vessel was a sound one, that it was able to carry its own car and motor, and that the apparatus might have been controlled by the proper number of men. The experiment, therefore, paved the way for the Zeppelin Airship.

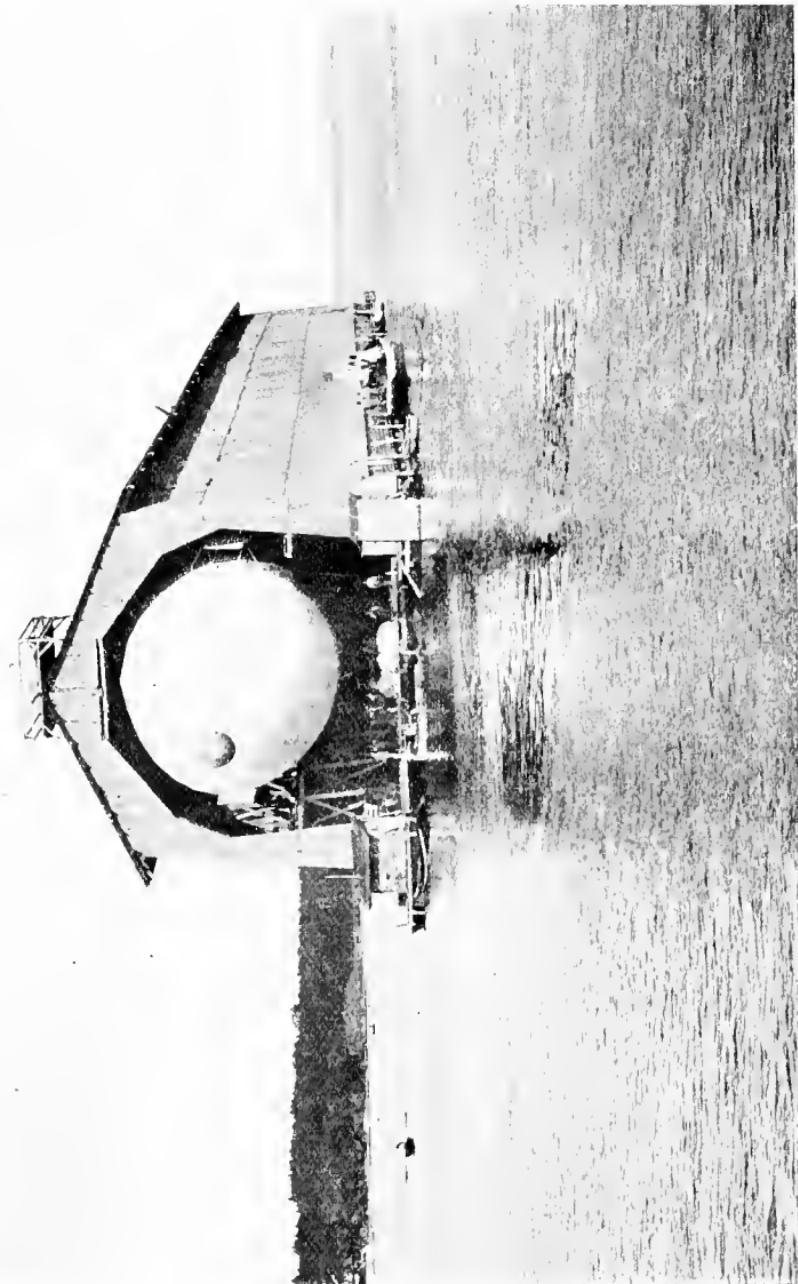
Maxim and Langley's experiments having meanwhile demonstrated that flying machines could really fly, the general hope that that era of universal flight depicted by George Cruikshank was rapidly approaching, naturally increased. Popular interest in aeronautics had therefore vastly increased when in the summer of 1900 Count Zeppelin virtually threw down the gauntlet to the school of which Maxim and Langley are such distinguished champions, and announced the ascent of his new air-ship. His balloon or aerostat was constructed with great care and at great expense—perhaps it never

had an equal in both of these respects—in a wooden shed on the lake, opposite the little town of Manzell. The cost of building this shed alone was over 200,000 marks; it rested on 95 pontoons, so that by anchoring his shed at one point only the inventor allowed it to turn as on one pivot, with the wind, in releasing his balloon from the shed with the least possible damage and the greatest available speed.

The whole had been built by a company with a capital of £40,000, to which Count Zeppelin had contributed one half, under the immediate patronage of the Emperor William II.

On June 30, an illustrious gathering of scientific men and aeronauts from all parts of Europe met to witness the trial of the aged inventor's air-ship.

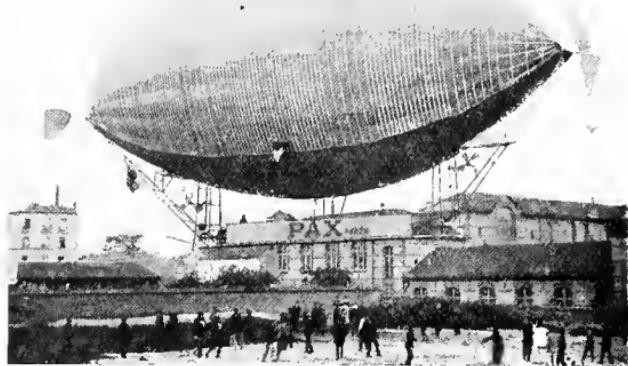
When the balloon was ready for its ascent it was taken out of its shed on its own pontoons, and the assembled spectators saw a huge cigar-shaped structure, conical at both ends, 390 feet long, with a diameter of about 30 feet. It appeared at first sight but a single aerostat, but it really consisted of 17 small aerostats, being divided into that number of sections each gas-tight. The interior was a framework of aluminium rods stretching from one end of the aerostat to the other and held in place by 17 polygonal rings, 24 feet apart. Each ring was supported by aluminium wires, and the whole machine was covered with a tough and light fabric of silk coated with india-rubber, and protected further from the outside by pegamoid. One filling of hydrogen was found to last for nearly three weeks, and



THE ZEPPELIN AIR-SHIP IN SHED BEFORE LAUNCHING.

as the total capacity was about 12,000 cubic yards, the cost of filling alone amounted to between £400 and £500.

The propulsion of the machine was to be effected by four screws made of aluminium, two being situated about a third of the total length from the bow, and the other two an equal distance from the stern. Each screw was calculated to make 1,000 revolutions a minute.



M. SEVERO'S AIR-SHIP—THE START.

The cars were two in number, also of aluminium, about 5 feet broad by 3 deep, and situated each beneath the screws. The chosen motive power was benzine, on account of the lightness of the motors using that fluid, enough of the latter being carried to last for ten hours in the air. Everything that the mind of the inventor and his friends could suggest was provided : for instance, sliding weights to regulate the angle of flight,

dragging cable, and aluminium rudders controlled by wires.

A delay in filling the balloon having occurred, the trial was twice postponed; and it was not until July 2nd, that the balloon, taken from the shed and held in position by several ropes, was allowed to rise about 75 feet. At eight o'clock in the evening it was released, and, with the Count and four assistants in the cars, began slowly to ascend. But when the engines began to work, it soon steamed against the wind, which was then blowing, turning to right and left, afterwards travelling with the wind, until Immenstaad, $3\frac{1}{4}$ miles distant, was reached.

But at the beginning of the journey, an accident happened to the steering-gear. The further use of the running weight was prevented by the breaking of a winch, and consequently it was rendered impossible to guide the vessel properly. Count Zeppelin, therefore, resolved to descend, and this was done satisfactorily, and without incident. This first experiment proved the rigidity of the aerostat, and also that its horizontal position could be maintained, but this was all.

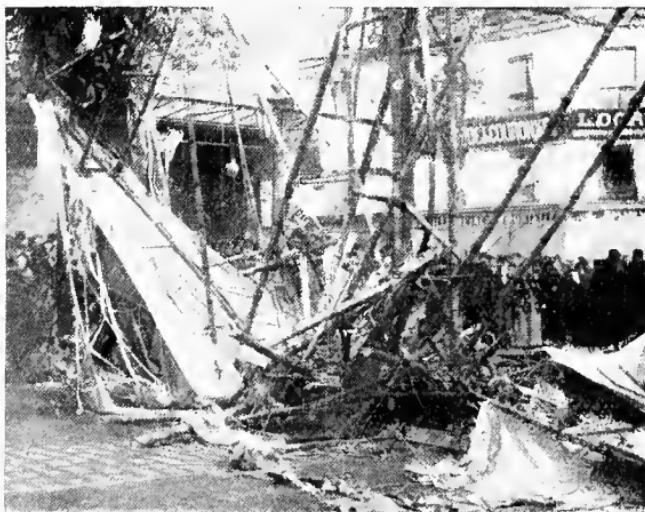
The science of aerostatics lost one of its pioneers early in 1900, by the death of the veteran, Henry Coxwell, at the age of 81. Coxwell's balloon ascents with Mr. James Glaisher, for the investigation of the meteorological conditions of the atmosphere at high altitudes, had long been prominent in scientific history. Coxwell has been termed the aeronaut *par excellence* of his time, and by far the most ready and ex-



THE ZEPPELIN AIRSHIP SAILING ABOVE LAKE CONSTANCE.

perienced handler of a balloon in Europe. Coxwell was a member of an old county family, resident at Ablington House, Gloucestershire, and the youngest son of Captain Coxwell, R.N. He was himself destined for the army, but early conceived a penchant for ballooning and aerial science. During his career he made over 500 ascents.

In France, a few months previously, there had



M. SEVERO'S AIR-SHIP, THE ACCIDENT—AVENUE DE MAINE.

occurred the death of M. Gaston Tissandier, who for many years had devoted much attention to ballooning, and was also an aeronaut of great distinction. He was nominated president of the French Association of Aerial Navigation, and his first memoirs on the application of electricity to aerial flight were crowned by the Paris Academy of Science.

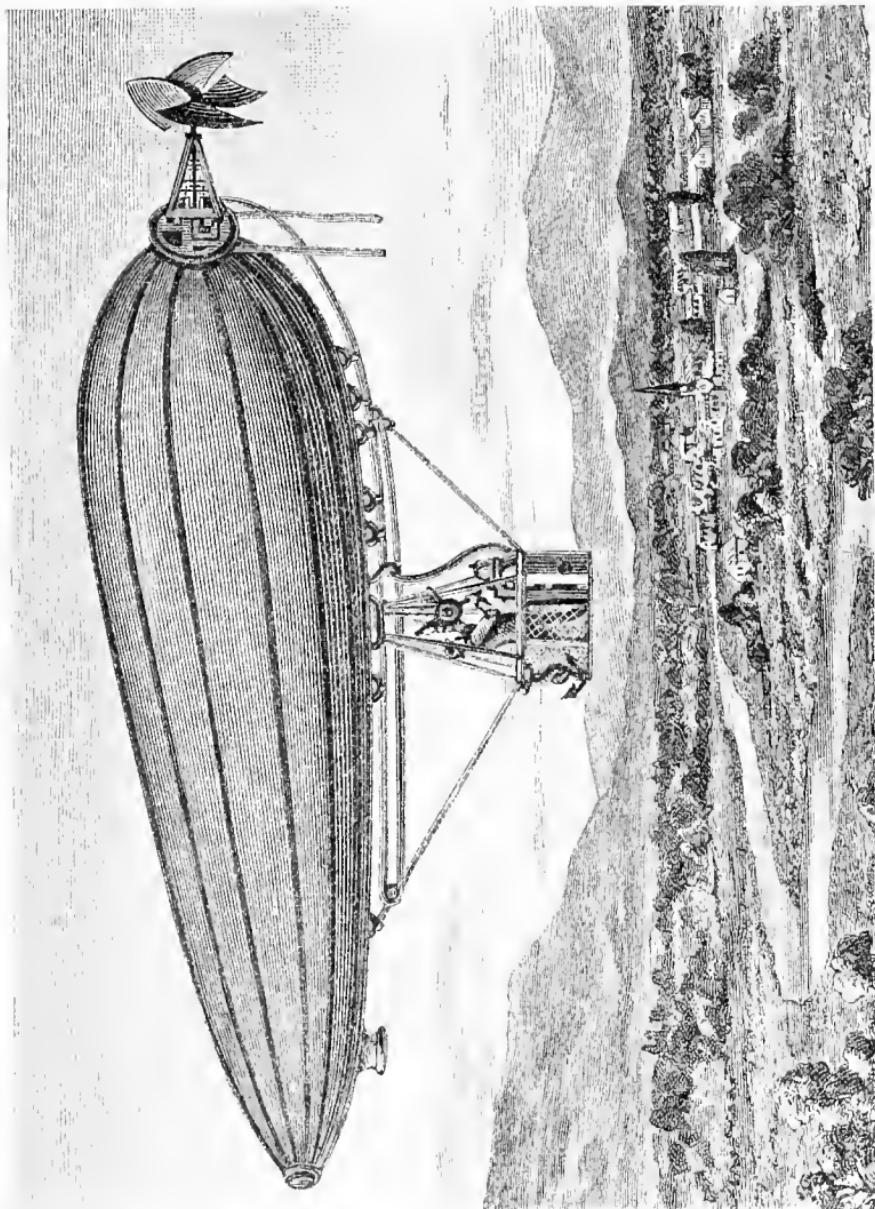
The story of the heroes of modern science might

of itself fill a volume much larger than the present one—men, who in the pursuit of an idea in physics or mechanics have risked, and too often sacrificed, their lives. In aeronautics, as might be expected, there is no lack of this sort of heroism—indeed, perhaps, there have been more, or at least more vivid examples, than in any other department.

Among the latest martyrs who have sacrificed their lives to effect a conquest of the air was Dr. Wölfert, a German aeronaut of distinction, who claimed to have invented a navigable balloon. In seeking to give a practical demonstration of his invention at Berlin, in June, 1897, the balloon exploded at a height of about 1,000 feet. Some mounted officers hurried to the spot where the fragments descended, and after the flames had with great difficulty been partially extinguished, the mutilated remains of Dr. Wölfert and his companion, a mechanic, named Knabe, were found amongst the ruins. It was thought that the valve of the balloon was opened, with the intention of descending, and the escaping gas became ignited by the benzine.

Lilienthal's principal disciple in this country was Percy S. Pilcher, who for some years continued to make a number of experiments with soaring machines. But like his forerunner, Pilcher finally came, in 1899, to the same sad end, and his name must, therefore, be added to the already long list of the martyrs of aerial navigation.

After several ineffectual attempts to start from



WÖLFERT'S STEAM AIR-SHIP.

Stamford Hall, Market Harborough, the inventor rose slowly in the machine until he had travelled about 150 yards, and had risen to a height of 50 or 60 feet. At that altitude a sharp gust of wind came, the tail of the apparatus snapped, the machine became completely overturned, and fell to the earth with great force. Pilcher was found to be unconscious, and died shortly after.

In the early morning of May 12, 1902, before Paris was astir, the left bank of the Seine was the scene of an accident which profoundly moved the hearts of all who admire the courage and enterprise of aerial experimenters. Over and over again, M. Santos Dumont, by the happiest of chances, escaped from a fearful death. The same good fortune was denied to his compatriot, M. Auguste Severo, a member of the Brazilian Parliament, whose initial trial in the aerostat "Pax" swiftly terminated in a shocking disaster. Severo's air-ship, which contained 2,345 cubic metres of gas, was constructed with two screws, one fore and one aft, carried on a shaft running right through the aerostat, or balloon, itself. The motor was in the car beneath, and was connected with the shaft by a vertical belting. At the height of 1,500 feet, just over the Avenue de Maine, the petroleum motor ignited some escaping gas from the aerostat, the balloon burst, and the aeronaut and his assistant, an engineer named Sachet, were precipitated to earth, the former being killed by the fall and the latter burnt to death by the explosion.

It was Mr. Percival Spencer's opinion that the cause of the accident lay in the faulty construction of the aerostat, and that the motor was placed too nearly in conjunction with it. In the air-ship of his own construction, with which experiments were made during 1902, he had taken the precaution of placing the automatic pressure valve well out of danger, and protected against the risk of ignition by wire gauze on the Davy principle.

Nevertheless, the greater risks in the use of the lighter and more powerful petrol engine are obvious, and must be reckoned with.

CHAPTER X.

THE investigators in aeronautics are at present divided into three camps. On the one hand, there are men who like Sir H. Maxim seek to construct machines which carry motors, and are self-propelling ; while, on the other, there are the aviators, who assert that a motor is unnecessary ; while, again, the principle of the balloon aerostat, or buoyancy chamber, is represented by Santos-Dumont, Spencer, Barton, and others.

The whole subject of aerial navigation, according to M. Octave Chanute, writing in 1893, resolves itself into ten problems and conditions :—

1. The resistance and supporting power of the air.
2. The motor: its character and activity.
3. Selection of the instrument to obtain propulsion.
4. The form and kind of apparatus for sustaining the weight—whether flapping wings, screws, or aeroplanes.
5. The amount of the sustaining surface required.

6. The best materials to be employed for the framing and for the moving parts.
7. The maintenance of the equilibrium, which is the most important, and, perhaps, the most difficult of solution of all problems.
8. The guidance in any desired direction.



TUE SANTOS-DUMONT NO. 1.

9. The starting up into the air under all conditions.
10. The alighting safely anywhere. Safety in starting, sailing, and alighting is essential.

No one can doubt that the problem of maintaining equipoise is the most important and difficult one the budding aerial navigator has to face. Almost every

failure in practical experiment has been due to this lack of equilibrium. According to Professor G. H. Bryan, F.R.S., "every one of the conditions for successful flight have been fairly satisfactorily dealt with by various experimenters; and it only remains to embody them in a single machine."



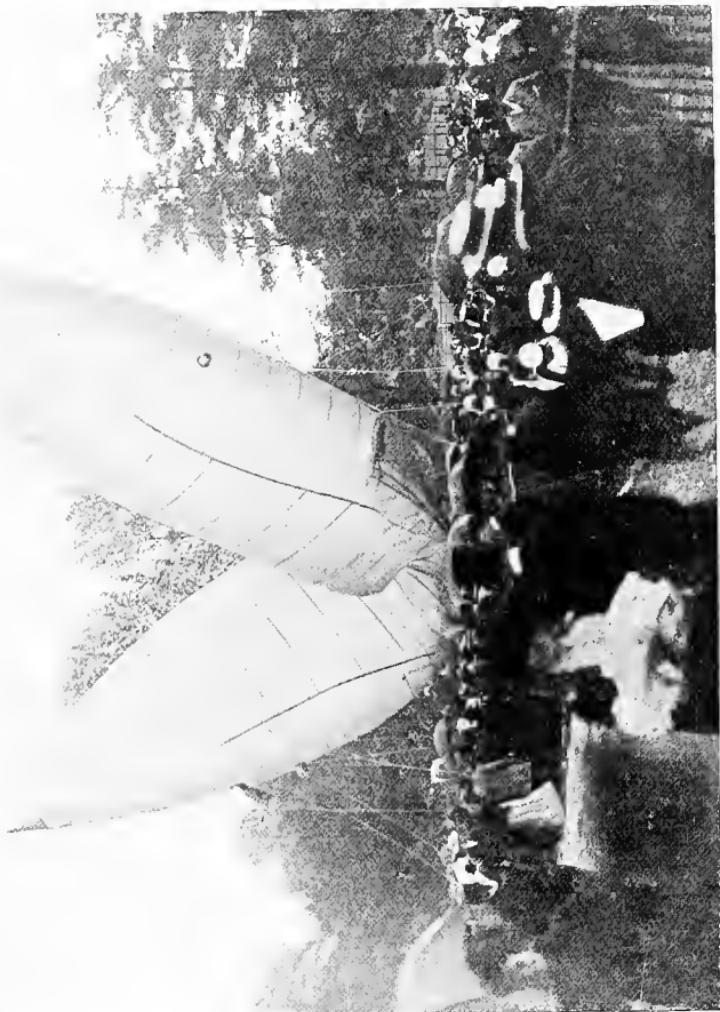
THE SANTOS-DUMONT NO. 2.

With the opening of the new century many projects for flying machines were newly set afloat. There was a flying machine of an Austrian engineer named Kress, and the so-called "auto-aviator," due to M. Firman Boussan. This latter was surmounted by a vertical oblong balloon, thus resembling Dr. Danilewsky's balloon, to be provided with curved

wings and propellers, and also with wheels by which it could run on the roads. To Mr. G. L. O. Davidson belongs the idea of a bird-shaped glider, the tail of which has movable parts, provided with automatic mechanism for regulating the balance and stability. It appears to have glided satisfactorily, but its significance was little after Langley's experiments.

The Russian Ministry of Marine has devoted especial attention of late to the question of turning to account aerial navigation in the Navy. Naval officers and certain ordinary seamen from various vessels have been attached for a time to the Balloon Post, for the purpose of learning how to handle balloons in their descent. During the last manœuvres of the Fleet experiments by means of balloons were carried out in scouting, taking observations, and in signalling on board the vessels forming the Black Sea Fleet. These experiments were satisfactory, and the Ministry intends to provide the manœuvring squadrons with balloons, and also to work out practically the question of making aerial navigation a useful branch of the Navy.

It seemed certain to aeronauts a few years ago that a balloon could not be driven against the wind, yet one American writer observed, "it is just as unreasonable to speak derisively of the balloon as it would be to comment unfavourably upon a floating dock because of the inability of the latter to win a prize in a yacht race." It was possible, he added,



AN ACCIDENT TO SANTOS-DUMONT AND HIS AIR-SHIP.

that we had not yet learned how to use the balloon.

The fact is, and it soon grew to be generally recognised, that the dirigibility of a balloon depended upon its shape, but principally upon the kind of motor



SANTOS-DUMONT GIVING THE SIGNAL.

employed. Electricity had not been a success; inventors now turned to petroleum. The light petroleum motors of Daimler, Mors and others were now available, weighing only some 10lbs. per horsepower.

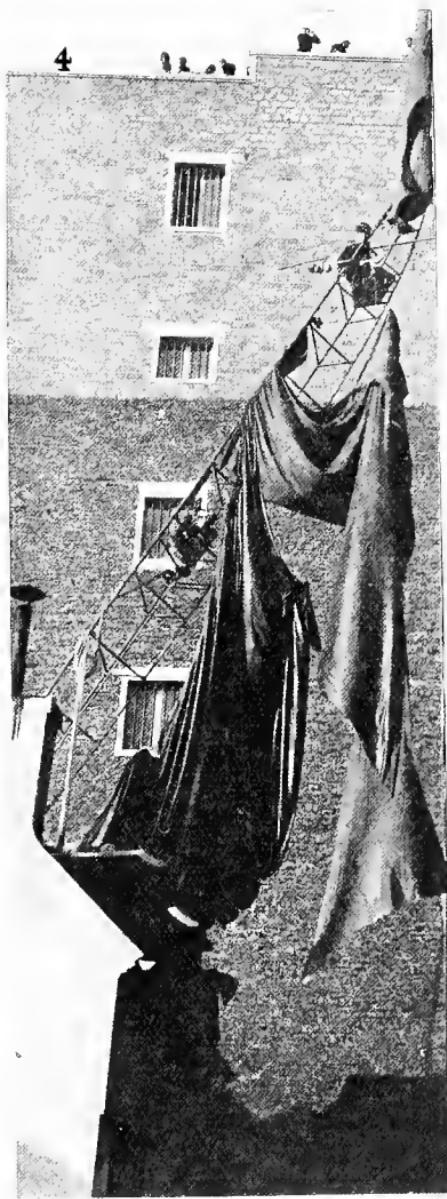
There had come to Paris a wealthy young Brazilian,

Alberto Santos-Dumont, the son of a coffee-planter. He had been interested in ballooning from childhood ; he met many amateur and professional aeronauts in the French capital, and in 1898 built his first balloon, in which he made an ascent. This he followed by others of elongated form, once having a narrow escape from death, falling some 800 feet to the ground.

While he was thus experimenting with screws, paddles, and other dirigible apparatus, a certain M. Deutsch offered a prize of 100,000 francs, under certain conditions, to the aeronaut who should ascend from a certain park in Paris, and make the circuit of the Eiffel Tower, returning to the place of ascent in the maximum time of half an hour.

M. Santos-Dumont no sooner heard of this announcement than, although he had scarcely recovered from his accident at Nice, he set about the construction of another balloon, the fourth of its kind, upon which he again bestowed his own name. In the "Santos-Dumont No. 4" its inventor sacrificed comfort to lightness, directing the movements of the machine from a frail bamboo saddle in bicycle fashion, wholly doing away with the car. In this equipage he embarked upon a series of almost daily experiments. An untoward accident caused the destruction of still another balloon at the commencement of 1901. This was 34 metres in length, supporting a surface of 18 metres, and having a perfect rigidity under a weight of 50 kilos.

From the 12th of July to the 8th of August, Santos-



AFTER AN ACCIDENT: THE RESCUE.

Dumont and his experiments obtained universal renown. On the former date the balloon, held by ropes, rose a few feet from the Park of Aerostation, with the inventor and proprietor in the car. The limits of the park were instantly passed, the Seine crossed, together with the Bois de Boulogne and the racecourse. The



ROUNDING THE EIFFEL TOWER.

word was given to let go. No fewer than ten times did the aeronaut traverse the field of Longchamps, then he went to Puteaux, and then to the Trocadero, where he broke and repaired on the spot the rudder of his balloon, circumnavigated the Eiffel Tower, returned to Longchamps, passed the Seine, and finally anchored at his starting place.

On the following day, before the appointed committee of aerostation, he effected in forty minutes the excursion from the park to the Eiffel Tower, and after a terrible struggle against a strong wind, in the course of which he descended on the trees of the estate of Edmond de Rothschild. Having repaired the balloon he set out again on the 8th of August for the Eiffel Tower, but on the return journey encountered a fresh accident, which practically destroyed the balloon, by collision with the roof of a lofty hotel in the Rue Alboni. Santos-Dumont himself met with a narrow escape from death on this occasion.

Twenty-eight days after this catastrophe the plucky aeronaut had constructed and equipped another machine, the "Santos-Dumont No. 6." This also, on its ascent, suffered a collision with a tree in the Bois de Boulogne; but at length, after numerous vicissitudes, its owner had the great satisfaction of accomplishing the feat which had so long baffled him. On the 29th of October the journey was made in 29 minutes 30 seconds, and the prize of 100,000 francs was won.

It is hardly necessary to add that this achievement rendered the aeronaut illustrious. Santos-Dumont became the hero of the hour, and from one end of Europe to the other it was proclaimed that the problem of a dirigible balloon was at last solved.

It is true that an English aeronaut, Dr. Barton, claims to have constructed a navigable balloon exactly similar to the present machine of M. Santos-Dumont as long ago as 1882. In 1898, after many experiments

with aerodromes and aeroplanes, he combined the two principles, by interposing an aeroplane frame and attaching more moveable aeroplanes between the balloon and the car.

He discovered, by satisfactory experiments, that the aeroplane obviated the necessity of letting out gas



IN FULL FLIGHT : THE RETURN.

when he desired the machine to descend, and of throwing out ballast when he wished it to rise.

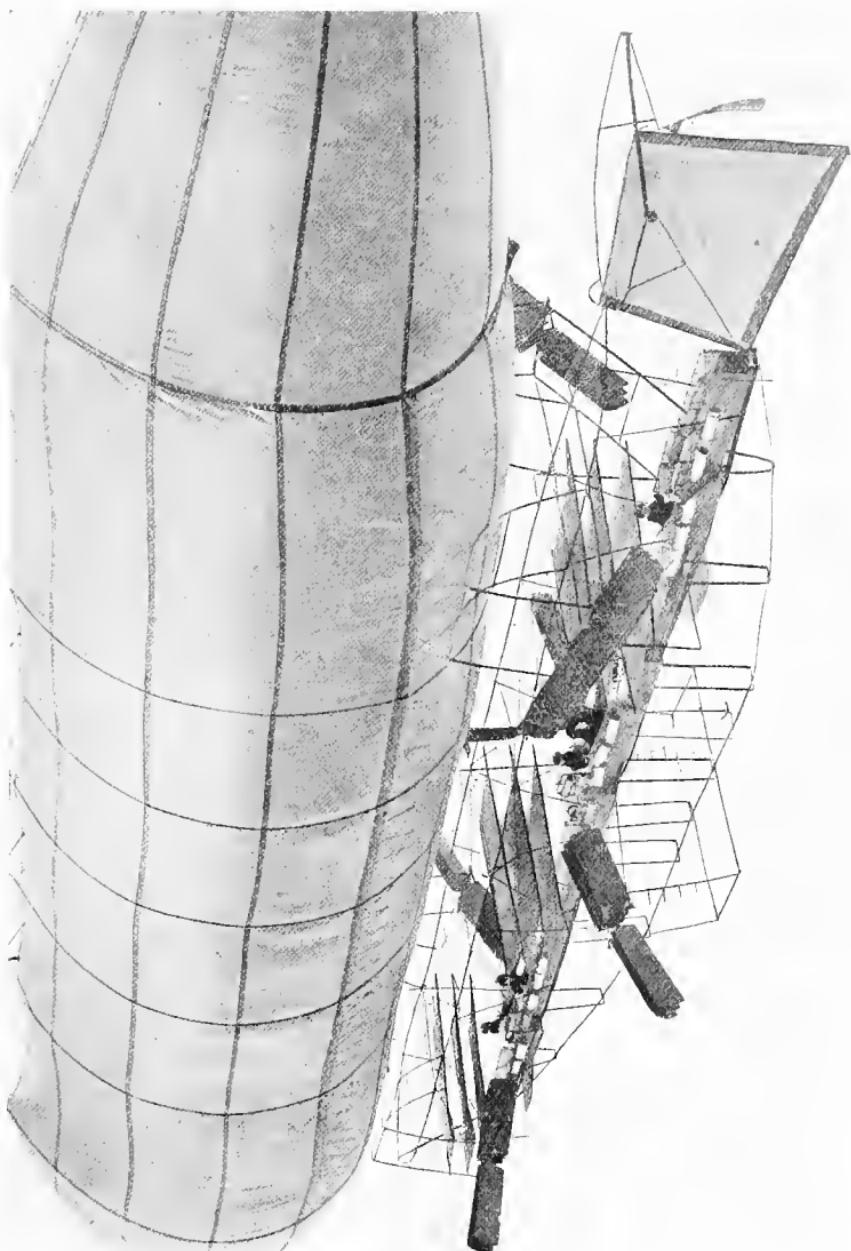
The new air-ship which he is at present constructing for the War Office will be 180 feet in length, and will weigh nearly 10,000 lbs. The deck will be about 104 feet long, and the machine will carry seven or eight persons, four being required to work it. The machine

will be driven by three pairs of propellers arranged on the sides of the car, each pair being worked by a 45 horse-power petrol motor. Attached to the machine an automatic water-balancing apparatus will keep it always perfectly horizontal, even when passengers walk along the deck. The framework of the machine will be made of tubular steel, and braced together by steel wire in tension. He estimates that the machine will be able to travel at the rate of 25 miles an hour, and remain in the air for a period of 48 hours.

The well-known balloonists, Messrs. Spencer, also recently achieved the construction of an air-ship, carrying a 30 horse-power Simms petrol motor, with which Mr. Stanley Spencer experimented at the Crystal Palace during the summer of 1902.

After all, whether we count the exploit of M. Santos-Dumont as foreshadowing a speedy utility or not, the balloon has already made possible a feat impossible by any other earthly means. "It has," remarks Mr. Glaisher, "gratified the desire natural to us all to view the earth in a new aspect, and to sustain ourselves in an element hitherto the exclusive domain of birds and insects. We have been enabled to ascend among the phenomena of the heavens, and to exchange conjecture for instrumental facts, recorded at elevations exceeding the highest mountains of the earth."

It was Mr. Glaisher's opinion that the importance of the balloon had always been exaggerated, and that "it should be received only as the first principle of some aerial instrument which remains to be sug-



DR. BARTON'S NEW AIR-SUIT.

gested. In its present form it is useless for commercial enterprise, and so little adapts itself to our necessities that it might drop into oblivion to-morrow, and we should miss nothing from the conveniences of life."

Whatever the shortcomings of the machine, lighter than the air, we must not forget what we already owe to it. It has given to science that which no human power could have bequeathed, opening for our vision those boundless plains of the air, far grander, and more awful and infinite than the blue deeps of the ocean. Bearing us on the wings of the zephyr, the invention of the papermakers of Annonay has enabled mankind virtually to take possession of atmospheric regions which had for centuries, since the creation of the world, in fact, seemed for ever closed to human audacity. Moreover, side by side with the scientific interest, it must not be forgotten that ballooning has widened the scope of man's imagination by enlarging the sum of his experience. There are, in these aerial voyages, a picturesque attraction, an unexpected charm, obtainable by no other means, superior even to that derived by the Alpine traveller after long and arduous labour to reach an icy summit.

Then again, in the words of M. de Fonvielle, commenting on the beautiful pictures of aerial landscapes exhibited in Paris thirty years ago, "If balloons, so much neglected in modern times, had merely placed before the gaze of the aerial explorer these incompar-

able panoramas, the magnificent scenes, before which the Alps themselves grow small, whilst earthly sunsets are eclipsed in splendour, and the ocean itself drowned in an ocean of light still more vast, would they not have done enough for the glory of Montgolfier and Pilatre?"

APPENDIX.

LIST OF AERIAL FATALITIES—1785-1902.

THE following is a nearly complete list of aeronauts who have met their death as a result of their aerial experiences since 1783:—

- 1785. Pilâtre de Rozier and Romain at Boulogne.
- 1801. Death of Olivari at Orleans (combustion of Montgolfière).
- 1806. Death of Mosment at Lille.
- 1812. Zambeccari was killed at Boulogne.
- 1812. Bittorf was killed at Manheim.
- 1819. Death of Madame Blanchard at Paris.
- 1824. Sadler was killed by a fall at Bolton.
- 1840. Letur (flying man) was killed in London.
- 1846. Cocking, in London (fell 3,700 feet).
- 1847. Emma Verdiér was found asphyxiated in her car.
- 1850. Goulston, in America.
- 1850. George Gale was killed at Bordeaux.
- 1850. Harris, in London (the valve not being closed).
- 1854. Arban disappeared in the Pyrenees.
- 1858. Deschamps, in France.
- 1863. Donaldson and Grimwood were killed in America.
- 1870. Prince and Lacaze, sailors, were lost at sea.
- 1873. Death of La Montaine in Iowa (U.S.A.).
- 1874. Death of the flying man, De Groof, in London.
- 1875. Crocés-Spinelli and Sivel, asphyxiated at 8,600 metres.
- 1876. Triquet (son) was killed at Issy.

- 1879. Petit fell 1,800 feet at Mans.
- 1880. Charles Brest was drowned in the Mediterranean.
- 1880. D'Armentières was drowned in the Mediterranean.
- 1880. Navarre fell from his balloon at Courbevoie.
- 1881. W. Powell disappeared with the balloon, *Saladin*.
- 1883. Laurens, at Philadelphia.
- 1883. Mayet was killed at Madrid.
- 1885. William Clarence, at Charlestown, Ohio.
- 1885. Jules Eloy was lost at sea.
- 1885. Gower was drowned in the Channel.
- 1887. Messrs. Mangot and L'Hoste met the same fate.
- 1888. Simmons, killed at Witham, Essex, his balloon bursting.
- 1888. American aeronaut, Vandegrift, drowned, following upon a burst balloon.
- 1889. Belgian aeronaut drowned in the Channel.
- 1889. Strut's balloon burst in America; fatally injured.
- 1891. August 11th, George Higgins killed at Leeds, and a French aeronaut lost in Channel.
- 1892. Capt. Dale and Mr. Shadbolt killed at Sydenham.
- 1892. Capt. Whelan died from a fall near Shrewsbury.
- 1893. M. Charbonnet killed near Turin.
- 1896. Dr. Lilienthal killed.
- 1897. Dr. Wolfert and his assistant killed near Berlin.
- 1900. Percy Pilcher killed.
- 1902. Senhor Severo and his assistant killed in Paris.

INDEX.

A.

ABEL, Sir F., 187, 222
Ader, 250
Agg-Gardner, 227
Aeronautical Congress, 260
Aldborough, Lord, 138
Allard, 10
Allen, 183
Amecourt, P. J. d', 148
Andreani, 37
Andrée, Herr S., 262, 265, 266, 269
Annonay, 17, 27
Argand, 37
Argyll, Duke of, 153 *note*, 171
Arlandes, M. d', 26, 31, 32
Artingstall, 80
Aviation, 73, 248, 250, 252

B.

BABINET, 162
Bacqueville, M. de, 13
Bacon, Roger, 3
Baden-Powell, 273
Balloons, first ascents, 17, 18
— first in England, 36
— first channel crossing, 39
— perfected by Charles, 33
— attempts at dirigibility, 38
— first ascent by a lady, 43
— two kinds of, 54
— reaction against, 56
— in warfare, 59, 178 *et seq*
— popular at fêtes, 80
— transatlantic projects, 114,
 118
— Nadar's opinion, 152
— at Siege of Paris, 190, *et seq*
— importance of, 318

Barton, 305, 316
Bazin, 237
Beaumont, 184, 187
Bell, Graham, 280
Berson, 270
Besnier, 10
Biot, 236
Black, Dr., 16
Blanchard, J. P., 38, 41, 51, 53, 76
Borelli, 8, 248
Boussan, 307
Bouvet, 212
Bowdler, 213, 220
Boyman, R., 171
Brearey, F., 225
Brewer, 128 *note*, 138
Bris, le, 140 *et seq*
Bruce, 225

C.

CAPAZZA, 213
Carlingford, 138, 139
Cavallo, T., 1, 16, 44
Cavendish's discovery, 1
Cayley, Sir G., 74, 75, 76
Cayrol-Castagnat, 214
Chanute, 226, 261, 305
Charles, 21, 28, 32, 33, 34, 35
Chartres, Duc de, 38
Christina, Queen, of Spain, 259
Clark, 236
Cocking, H., 104
Cordenons, 232
Cornelius, 245
Coutelle, 60, 61
Crocé-Spinelli, 220
Coxwell, H., 136, 137, 164, 187, 223,
 226, 299

D.

DALE, 247
 Dandrieux, 176, 226
 Danilewsky, 307
 David, 163
 Davidson, 308
 Degen, 59, 73
 Delamarne, 188
 Delcourt Depuis, 128
 Desforges, Abbé, 14
 Deutsch Prize, 312
 Durouf, 202

E.

EDISON, 78, 231
 Esterno, D', 142, 166

F.

FARIOT, E., 261
 Flight, First instances of Human, 2
 Fonvielle de, 70 *note*, 321
 Franklin, B., 32
 Frost, E. P., 259
 Fryers, 258

G.

GALIEN, 16
 Gambetta, 192, 224
 Garnarin, 62, 63, 70, 104, 162
 Gay-Lussac, 65, 69, 177
 Gerard, 59, 73
 Gerli Bros., 37
 Gibson, 174
 Giffard, H., 148, 210
 Godard, 153, 160
 Glaisher, J., 177, 219, 270, 296, 318
 Goulston, 135
 Graffigny, M. de, 273
 Graham, Mr. and Mrs., 79, 210
 Green, Charles, 70 *note*, 78, 79, 81,
 102, 114
 Groof, de, 175
 Grover, Col., 187
 Guzman, 15
 Gustafson, 238

H.

HANLEIN, 172
 Hargrave, L., 237
 Harris, 134
 Hecke, Dr. van, 128
 Helmholtz, 252
 Henson, 125 *et seq.*
 Hering, 261
 Holland, R., 81

J.

JEFFRIES, 53, 54
 Jobert, 213, 220
 Jones, H. B., 188 *note*
 Jullien, 173, 189

K.

KELVIN, Lord, 279
 Kites and kite balloons, 235, 236, 273,
 274
 Koch, Gustav, 258
 Krebs, 232
 Kuparento, 104

L.

LANA, F., 7
 Landelle, M., 140
 Langley, 226, 280, 283, 284
 Lennox, 122
 Leonardo da Vinci, 8, 58, 73
 Letur, 135
 Lewis, Sir W., 48
 L'Hoste, 213, 246
 Lilienthal, 5, 59, 75, 252, 254 *et seq.*,
 260, 279
 Lome, Dupuy de, 208
 Louvrié, de, 165, 168
 Lowe, Prof., 181
 Lucy, de, 140
 Luff, H. G., 178
 Lunardi, V., 44, 45, 50, 58, 75
 Luze, de, 189

M.

MACRIVEIN, 59
 Maguire, Sir R., 52
 Maillot, 237
 Mangot, 246
 Marey, 248
 Mason, Monck (his narrative), 81 *et seq.*, 104
 Maxim, Sir H., 241, 276, 279, 305
 McClellan, Gen., 182
 Mensnier, 121, 122, 212
 Michel, 172
 Middleton, 259
 Monge (*see* Marey Monge), 42, 120, 248
 Montgolfier, The Bros., 17, 24, 35, 36, 43, 322
 Moore, 245, 259
 Morton, 245
 Morveau, G. de, 60
 Mouillard, 248
 Moy, T., 214

N.

NADAR, 152
 Napoleon I., 42, 60, 70, 71
 Napoleon III., 189, 190
 Nobel, 262
 Noble, 223
 Nordenfeld, 266

O.

OTTO, 241
 Owen, 245

P.

PARIS, Siege of, 190
 Parkinson, 238
 Parseval, Capt., 274
 Paucon, 161
 Paul, 261
 Pauly and Egg, 77
 Pauze, de la, 216
 Pénaud, 167, 211
 Pétin, 129
 Phillips, H. F., 258

Pilcher, 5, 257, 300
 Pomes, 216
 Powell, W., 227
 Priestly's work, 17, 21

R.

RAYMOND, 253
 Renard, 232, 266
 Richet, 284
 Rieckert, 238
 Rittenhouse, 28
 Robert, 28, 32, 33
 Rozier, Pilatre de, 26, 31, 36, 43, 55, 260, 322

S.

SADLER, 51, 76
 Sage, Mrs., 52
 Sanson, 131
 Santos-Dumont, 303, 305, 312, 315, 316
 Schwarz, 287, 288, 291
 Sheldon, Prof., 51
 Simmons, 164, 236, 246, 274
 Sivel, 220
 Severo, 303
 Smythies, 145, 147
 Snow, 236
 Spencer, C., 174
 Spencer, P., 245, 304, 305, 318
 Stevinius, 6
 Steiner, 183
 Stevens, C., 78
 Svenskund, 266

T.

TATIN, 284
 Temple du, 166, 219
 Tempier, 223, 227
 Testu-Bressy, 57
 Thayer, 185
 Thible, Mme., 43, 52
 Tissandier, 190, 191, 220, 226, 299
 Todd, Prof., 260
 Tytler, James, 44, 45

V.

VANDEGRIFT, 246
 Vaussin Chardanne, 175
 Vauxhall, 80
 Vert, 189
 Villeneuve, 168
 Vogt, 214
 Voyages, notable, 34, 50, 53, 63, 64,
 76, 81, 117, 137, 145, 158, 161, 228,
 232, 262, 316

W.

WALKER, 75
 Walpole, H., 51, 52, 56

Wellington, 258

Wells, Miss C., 172
 Wenham, 167, 236, 248
 Wilcox, 28
 Windham, 52
 Wise, W. L., 226, 274
 Wise, J., 106 *et seq.*, 145, 242
 Wölfert, 300
 Wolseley, 228

Z.

ZAMBECCHARI, Count, 36, 65
 Zeppelin air-ship, 291 *et seq.*

